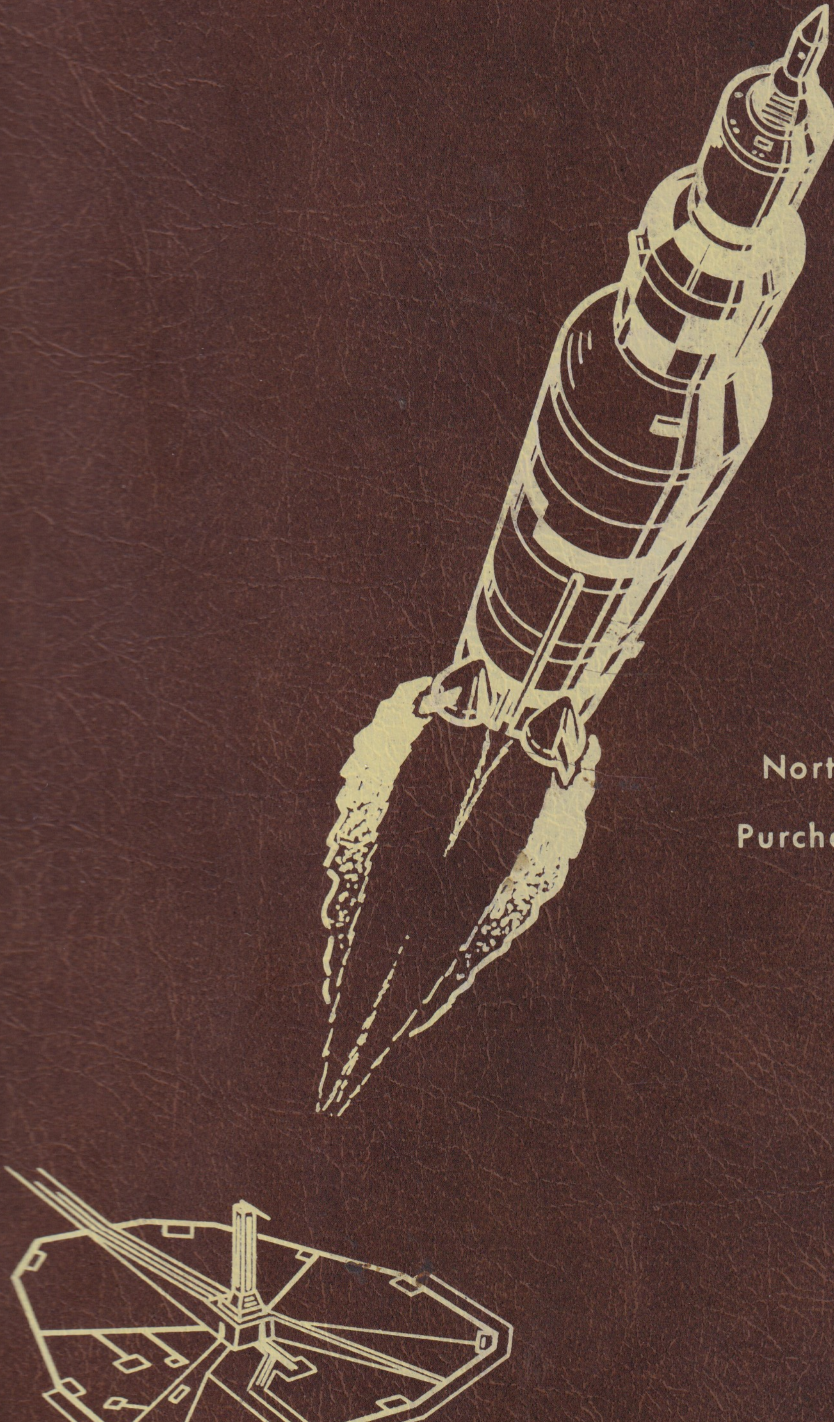
APOLLO MISSION SIMULATOR

Maintenance And Repair Procedures Manual



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LINK GROUP

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NASA
SUPPORT MANUAL

APOLLO MISSION SIMULATOR MAINTENANCE AND REPAIR PROCEDURES MANUAL

012 CONFIGURATION

VISUAL SYSTEM MANUAL

CONTRACT NASA 9-150 DX-A2

VOLUME I OF II

Sections I through VII

The undersigned certifies that this publication has been prepared in accordance with the applicable portion of SID 62-98; that the content is technically accurate and complete, and describes the equipment for which it was prepared as of the date of publication.

22 December 1966
(Date)

C. E. Meldrum Jr.
(Contractor Representative)

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SECTION I

DESCRIPTION

1-1. GENERAL.

1-2. The Apollo Mission Simulator Visual System (see figure 1-1) is designed to provide the astronaut with realistic "out the window" displays such as would be experienced during any phase of an actual Apollo mission. Simulation of the earth, moon, stars, spacecraft (in two windows), and other true to life images ranging from five feet to infinity is accomplished optically and electronically. The visual displays are provided for four of the five command module windows; the hatch window being the exception. Visual reference cues are also provided for the telescope and sextant, thus allowing the astronaut to train in the procedures of sighting landmarks and navigational stars.

1-3. The onboard equipment associated with the visual displays consists of a telescope and a sextant. Although optically different, they are nearly identical in physical appearance to their operational counterparts, and when used by the astronaut, operate in the same manner. The scenes viewed through the telescope and sextant duplicate the scenes (with the exception of spacecraft images) which might be viewed from the operational spacecraft in size, general appearances, and relative distance.

1-4. PHYSICAL DESCRIPTION.

1-5. Surrounding the command module are five frame-type structures, one for each window display and one for the sextant and telescope. The structures contain the necessary optical lenses, lights, and mirrors required fo project the images of visual scenes to a point where they can be viewed by the astronaut from his position inside the command module. The scenes are presented at infinity via the optical system to prevent a false parallax when the astronaut moves his head. Also mounted on the structures are the necessary projectors, television screens, and starfields needed for producing the visual effects.

1-6. Housed in a light-tight enclosure, physically separated from the command module and surrounding framework structures, is the rendezvous and docking simulation equipment. Included in this equipment are two television cameras mounted on a movable carriage, the target vehicle module model, sun lamps, reflected light lamps, and associated electronic and mechanical servo-driven assemblies.

1-7. Set apart from the command module area is the instructor-operator station (IOS). Controls and displays are provided at this station on a semicircular console for monitoring, recording, and controlling the various aspects of the simulated mission. From this position the instructor-operator personnel can evaluate the astronauts' performance.

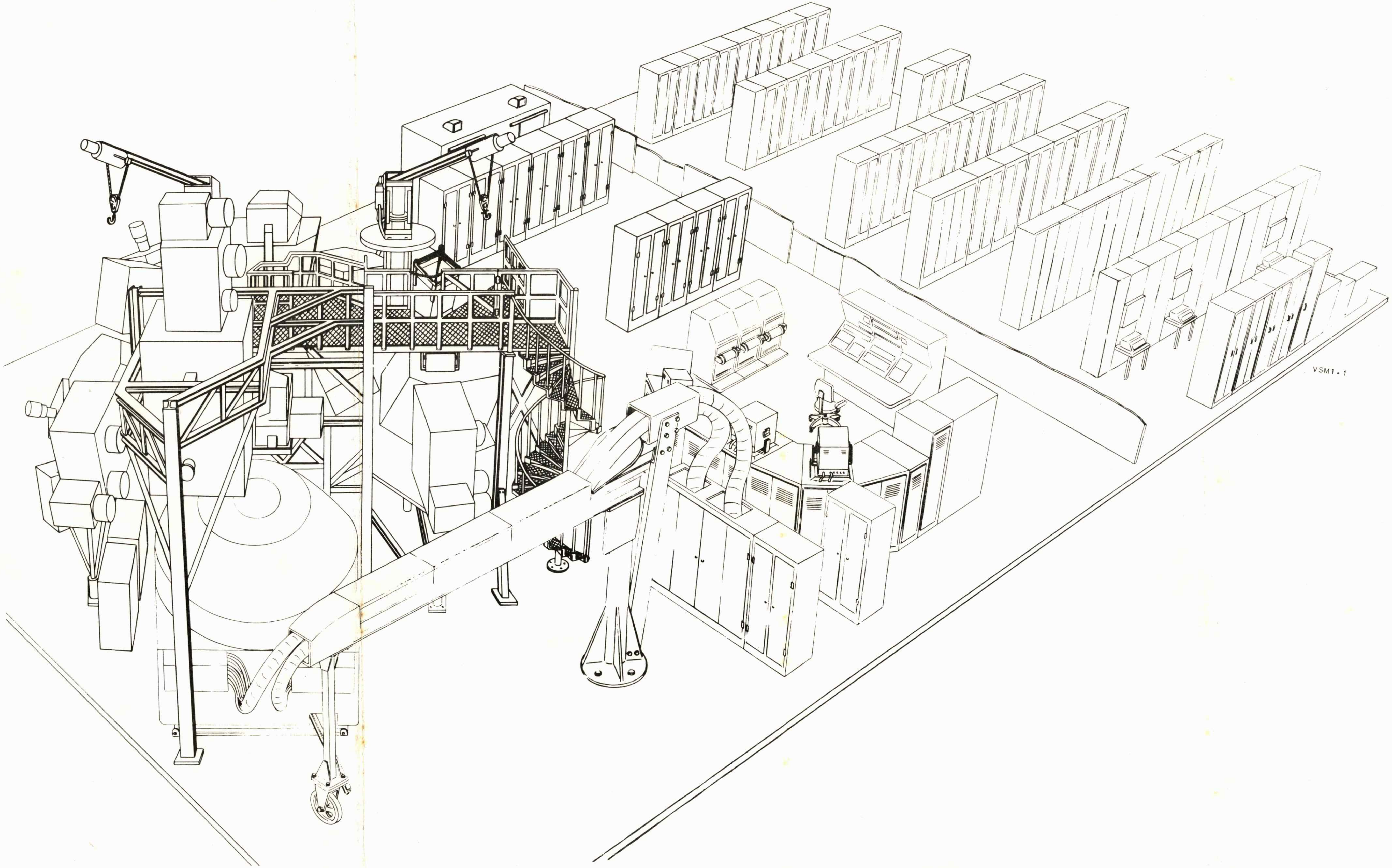


Figure 1-1. Apollo Mission Simulator Visual System

1-8. In support of the previously mentioned visual equipment are nine cabinets, containing the power supplies, servos, relays, and other electronic equipment. These cabinets are numbered 6, 7, 8, 9, 10, 70, 71, 72, and 73. Each cabinet is associated with a particular area of the visual system, and all the cabinets receive their power from a power distribution cabinet labeled unit 61.

1-9. TELESCOPE AND SEXTANT.

1-10. The AMS telescope/sextant subsystem consists of three units which function as part of the overall Apollo Mission Simulator (AMS). These units are the AMS telescope (unit no. 13), (hereafter referred to as telescope); the AMS sextant (unit no. 12), (hereafter referred to as sextant); and the AMS telescope/sextant electronics cabinet (unit no. 9). During a simulated mission, these units are used to train the astronaut in the navigational procedures required during various phases of the actual mission. Visual scenes, generated by projection devices within the system, simulate the field of view as seen through the telescope and sextant in the actual command module. These scenes duplicate command module attitude changes and motion along the flight trajectory by the movement of the variable-position optical elements incorporated in the AMS telescope and sextant. The optical elements are maintained in a dynamically correct positional relationship by means of positioning signals generated in digital form by the AMS computer. These signals are converted to analog positioning voltages and applied to servomechanisms in the AMS telescope and sextant via electronic equipment in unit 9. This equipment uses the analog positioning voltages to develop error signals which are used to drive the associated servo motors. Paragraphs 1-12 through 1-22 give a complete description of the telescope, and are followed by paragraphs describing the sextant and associated electronics cabinet.

1-11. Operational procedures of the simulated telescope and sextant are identical to those used in the actual spacecraft. When taking navigational sightings, the landmark is first located with the telescope in a 60 degree field of view. When the sighting with the telescope is accomplished, the sextant is used and the star and landmark must be superimposed in the sextant's 1.8 degree field of view. Once the landmark and star are superimposed, a button is pressed and the spacecraft location is automatically computed. A pictorial representation of the telescope and sextant measurement simulation is illustrated in figure 1-2.

1-12. **TELESCOPE.** The purpose of the telescope in the visual system is to permit training of the astronaut in all phases of the operations used in actual flight. Training includes identification of landmarks and navigational stars; and the selection of alternate landmarks, when they are required due to obscuration of the optimum landmark by clouds. The telescope also provides simulation of sunshafting in the optical path to warn the astronaut to re-orient the instrument. The telescope further provides realistic simulation of occultation of the viewed images due to C/M interference with the line of sight, and also the closing of the telescope protective doors.

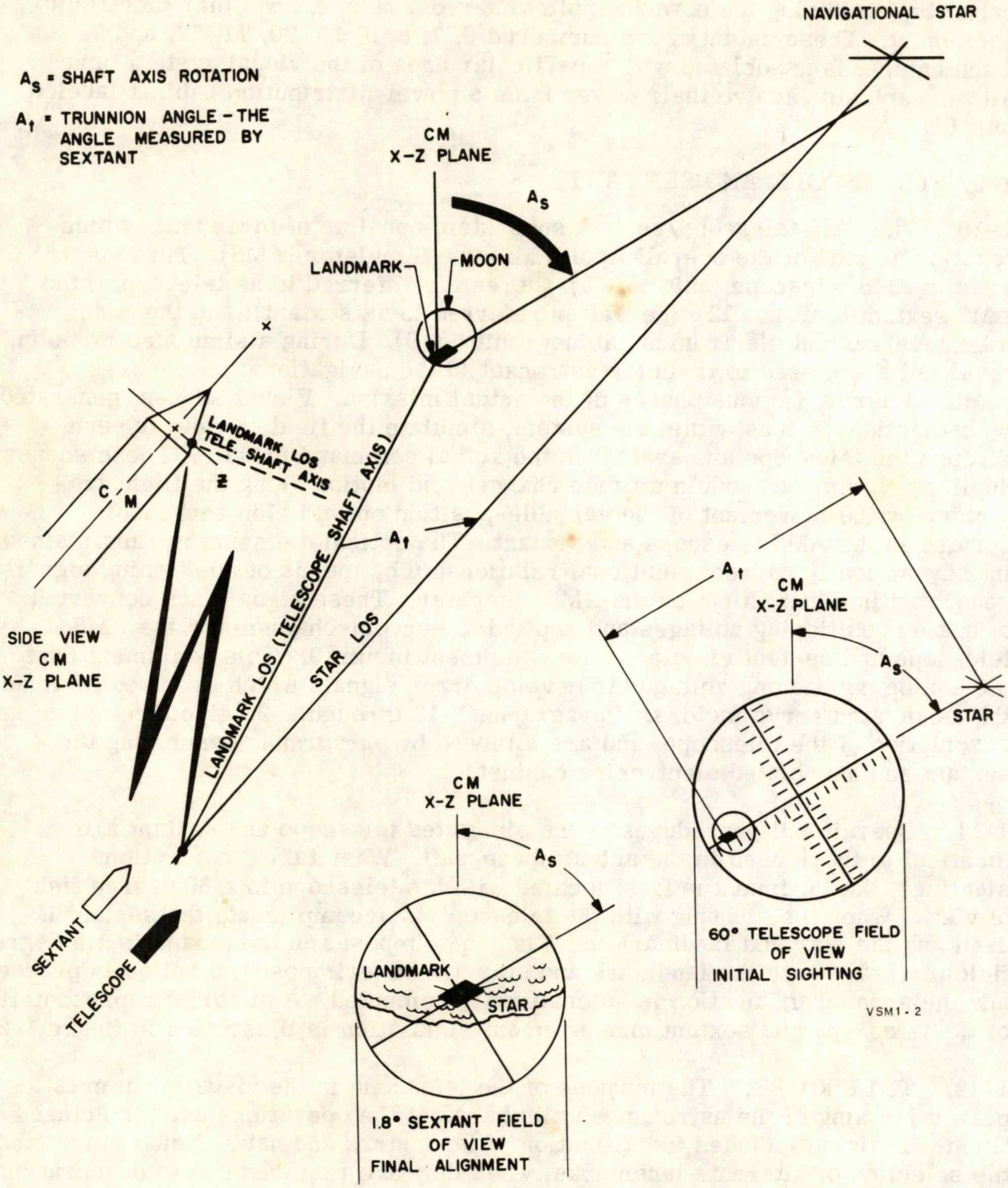


Figure 1-2. Telescope and Sextant Measurement Simulation

1-13. Telescope Major Components. (See figure 1-3.) Table 1-1 lists the major components of the telescope in tabular format, and also indicates their physical locations in the landmark, starfield, and combined lines-of-sight. Figure 1-4 includes a basic flow diagram and an expanded flow diagram of both the electrical signal paths and the optical paths of the telescope.

1-14. Associated And Integrated Equipment. Three pieces of equipment are assembled into and form parts of the telescope:

a. The mission effects projector (MEP) with its own illumination system and driving components.

b. The celestial sphere (C/S) and driving components.

c. The celestial sphere illuminator and occulting system.

Electrical signals required to drive the above three assemblies are supplied from a separate electronics cabinet, unit No. 10, of the AMS system.

1-15. The MEP is, essentially, a picture projector that presents various preselected images of earth and lunar scenes on a curved screen which are viewed by the astronaut through the telescope's MEP (or landmark) line-of-sight optics. The MEP incorporates its own illumination source; and landmark scenes are presented in frame sequence, as opposed to motion picture sequence, by computer generated electrical signals. A complete description of the MEP is included in paragraphs 1-106 through 1-130.

1-16. The celestial sphere provides the simulated image of the stars and is viewed through the telescope's starfield line of sight optics. Steel balls of varying diameters are imbedded in the surface of the sphere; the balls are arranged to correctly represent the constellations from which the 28 navigational stars are selected. The varying diameters represent the difference in magnitude of the stars, ranging from -1 magnitude through 5.0 magnitude. Duplication of the constellation pattern and magnitude permits training of the astronaut in recognizing the navigational star he is viewing during the navigational sighting. The celestial sphere is capable of being rotated 360 degrees around three mutually perpendicular axes; thus permitting the positioning of the selected navigational star in the telescope's starfield line of sight. For a complete description of the celestial sphere, refer to paragraphs 1-75 through 1-105.

1-17. The celestial sphere illuminator supplies light of the required intensity to flood the 60-degree field of view selected. The occultation feature incorporated in the illumination system provides a means for occulting that portion of the field of view which, unless occulted, would present the appearance of stars between the Apollo C/M and the landmark presented by the MEP. Since this condition could not exist, the occultation is required for true simulation. Paragraphs 1-91 through 1-105 give a complete description of the illumination and occultation systems.

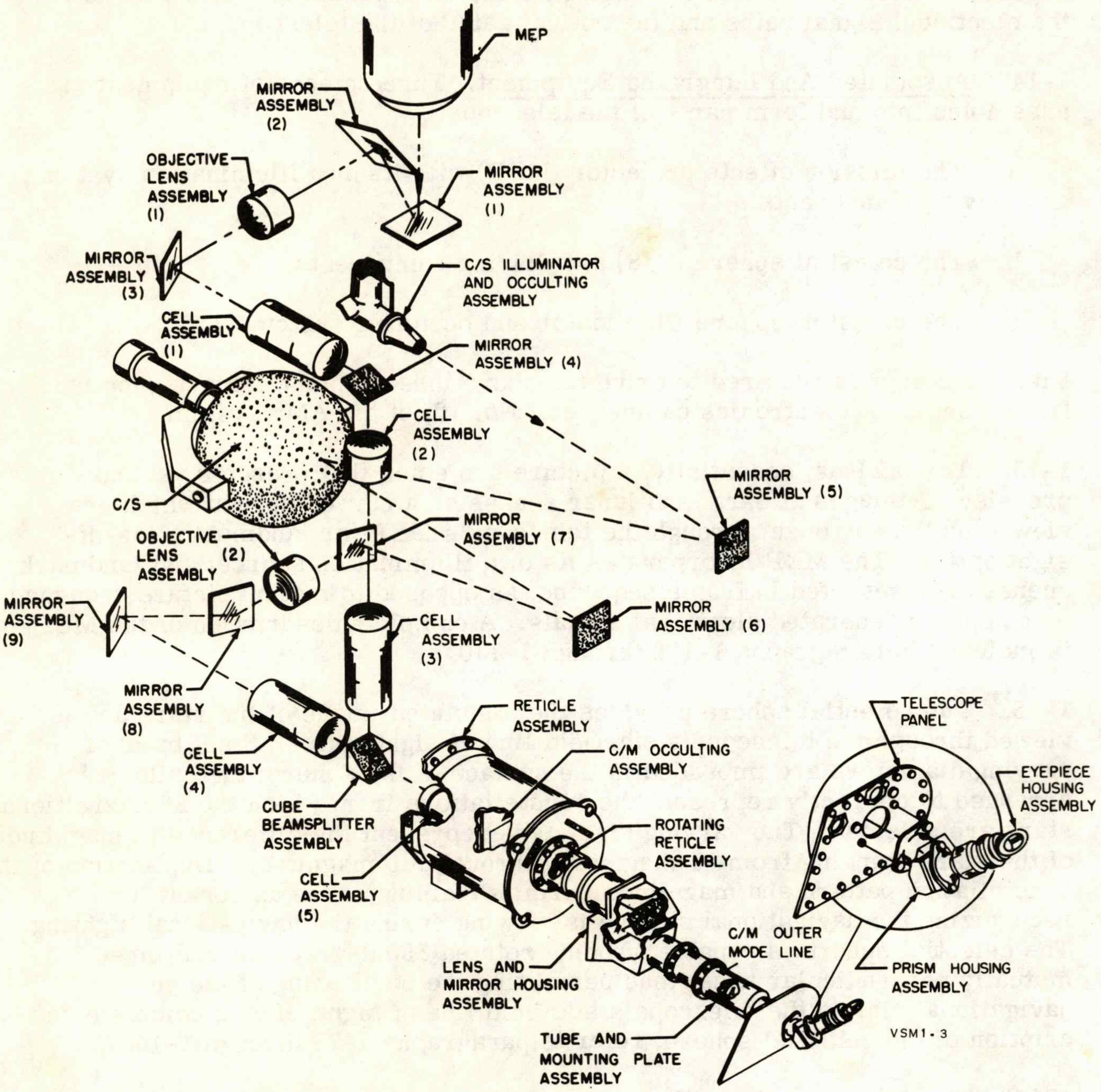


Figure 1-3. Telescope Component Arrangement

Table 1-1. Telescope Components

Nomenclature	Common Name	Specific Function
Frame Assembly	Frame	Supports the optical bridge, MEP, celestial sphere, C/S illuminator and occulting system, eyepiece tube and mounting plate assembly, and the telescope cover plates.
Optical Bridge Assembly	Optical Bridge	Inside the frame, the optical bridge provides support for the mirrors, lens cells, and the cube beamsplitter that optically transmits the MEP image through the landmark LOS, and the celestial sphere image through the starfield LOS to the cube beamsplitter, by means of which the combined LOS is formed. Externally, outside the telescope cover plates, the optical bridge supports the reticle, occulting, and lens assembly.
Landmark LOS		
Mission Effects Projector	MEP	Presents landmark scenes of the Earth or Moon.
Mirror Assembly (1)	Mirror	Reflects MEP scene into landmark LOS.
Mirror Assembly (2)	Mirror	Reflects MEP scene toward objective.
Objective Lens Assembly (1)	MEP Objective	Focused on MEP screen and transmits image beam into the optical system.
Mirror Assembly (3)	Mirror	Provides required reflection of MEP image for proper optical path orientation.
Cell Assembly	Lens Cell	Part of MEP image relay system.
Cell Assembly (1)	Lens Cell	Part of MEP image relay system

Table 1-1. Telescope Components (Cont)

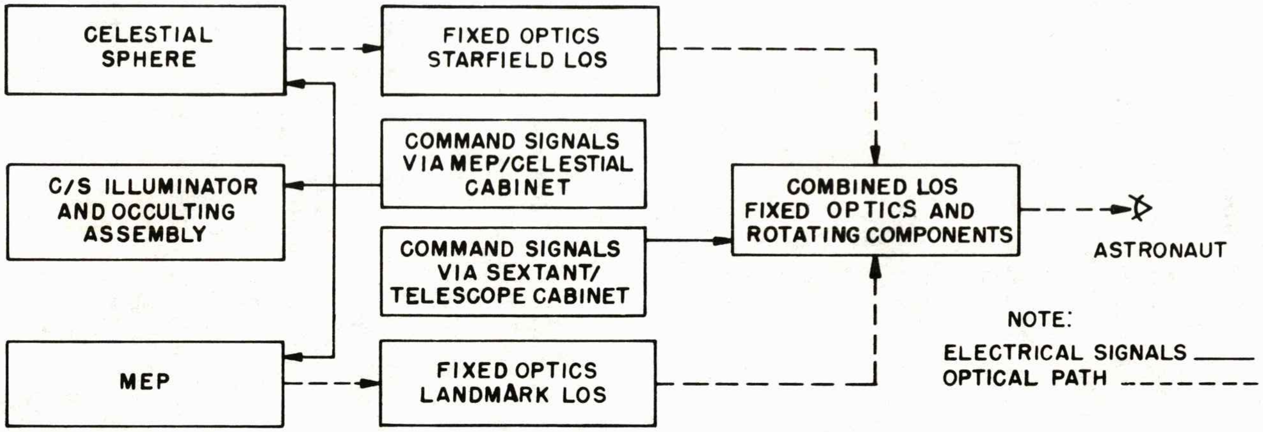
Nomenclature	Common Name	Specific Function
Mirror Assembly (4)	Mirror	Part of MEP image relay system.
Cell Assembly (2)	Lens Cell	Part of MEP image relay system.
Cell Assembly (3)	Lens Cell	Part of MEP image relay system.
Cell Assembly	Lens Cell	Part of MEP image relay system.
Starfield LOS		
Celestial Sphere Assembly	Celestial Sphere	Presents simulation of northern and southern celestial hemispheres.
Illuminator and Occulting Assembly	CS Illuminator and Occulting Assembly	Illuminates a portion of the celestial sphere that represents the telescope's 60 degree field of view. The occulting mechanism (part of the assembly) occults that portion of the illuminated field of view that would present the appearance of stars between the command module and the landmark scene presented by the MEP.
Mirror Assembly (5)	Mirror	Reflects the light beam from the C/S illuminator to impinge on the celestial sphere.
Mirror Assembly (6)	Mirror	Reflects starfield image toward the starfield objective.
Mirror Assembly (7)	Mirror	Reflects starfield image toward the starfield.
Objective Lens Assembly	Starfield Objective	Focused on celestial sphere and transmits the starfield image beam into the optical system.
Mirror Assembly (8)	Mirror	Provides reflection of the starfield image for proper optical path orientation.

Table 1-1. Telescope Components (Cont)

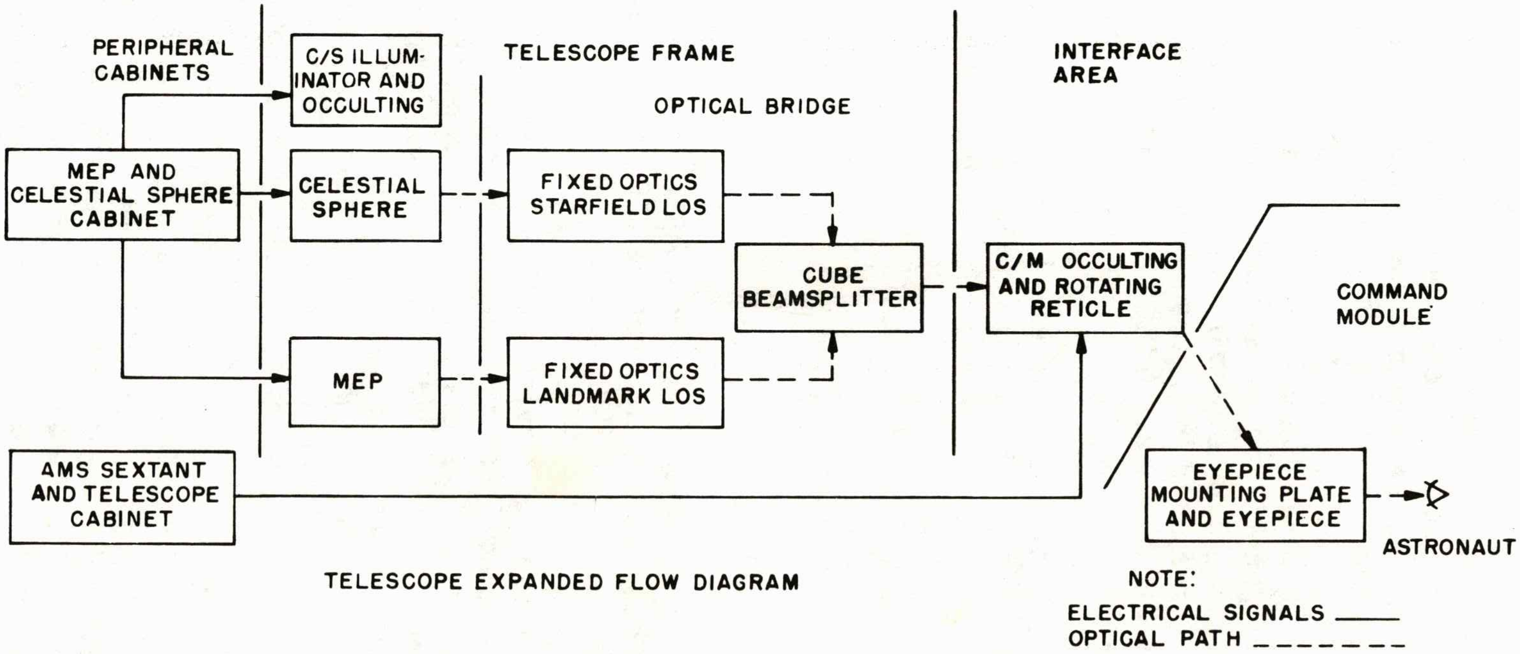
Nomenclature	Common Name	Specific Function
Mirror Assembly (9)	Mirror	Provides reflection of the starfield image for proper optical path orientation.
Cell Assembly (4)	Lens Cell	Part of Starfield image relay system.
Cell Assembly (4)	Lens Cell	Part of Starfield image relay system.
Combined LOS		
Cube Beam-splitter Assembly	Cube Beamsplitter	Combines MEP and celestial sphere optical paths.
Reticle, Occulting and Lens Assembly consisting of:		Provides a means for assembling and housing the three assemblies listed below into one removable assembly.
Cell Assembly (5)		Part of combined images relay system.
Command Module Occulting Assembly	C/M Occulting Unit	Simulates image occultation due to interference of command module window edges or corners and the telescope's field of view.
Rotating Reticle Assembly	Rotating Reticle	Duplicates appearance of operational telescope's reticle and provides 360 degrees of reticle rotation. Located at a system focal plane common to both MEP and starfield lines of sight.
Tube & Mounting Plate Assembly consisting of:		An assembly of all the assemblies listed below provides a path for the combined LOS from the rotating reticle to the Astronaut's navigating position inside the C/M.

Table 1-1. Telescope Components (Cont)

Nomenclature	Common Name	Specific Function
Lens & Mirror Housing Assembly consisting of:		Provides a housing for the four components listed below, as well as for a sunshafting simulation lamp.
Cell Assembly	Lens Cell	Part of combined images relay system.
Mirror	Mirror	Provides image reflection for proper optical path orientation.
Mirror	Mirror	Provides image reflection for proper optical path orientation.
Cell Assembly	Lens Cell	Part of image relay system.
Sunshafting Lamp Assembly	Sunshafting Lamp	Simulates sunshafting effect.
Cell Assembly	Lens Cell	Part of image relay system.
Cell Assembly	Lens Cell	Part of image relay system.
Eyepiece Mounting Panel	Telescope Panel	Simulates physical appearance of actual capsule eyepiece panel and provides mounting for prism housing and eyepiece housing.
Prism Housing Assembly	Prisms Housing	Duplicates prism housing in the operational telescope and provides reflections of the image required for proper optical path orientation.
Eyepiece Housing Assembly	Eyepiece Housing	Closely simulates the appearance of the operational telescope's eyepiece, and provides the optical system exit pupil.



TELESCOPE BASIC FLOW DIAGRAM



TELESCOPE EXPANDED FLOW DIAGRAM

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Figure 1-4. Telescope Flow Diagrams

1-18. Hardware Description. The telescope (see figures 1-5 and 1-6) is a completely enclosed unit that, with the MEP installed, resembles two large rectangular boxes stacked vertically; the MEP is mounted on top of the telescope's frame. The driving components of the celestial sphere project from the rear surface of the telescope, and the C/S illuminator and occulting assembly housing projects from the side of the telescope opposite the AMS sextant. A casting, which houses several components of the optical system, projects from the front surface of the telescope. An eyepiece tube projects downward at an angle of 32.5 degrees, passing through a clearance hole in the top section of the command module. The eyepiece tube terminates in a mounting panel to which the removable telescope eyepiece assembly is attached. The eyepiece tube is in two sections, and is flange connected near the command module outer mold line. Disconnection of this flange permits removal of the entire telescope, leaving the lower portion of the tube and the mounting panel and eyepiece inside the command module.

1-19. Overall Dimensions and Weight. The over-all dimensions of the telescope outside the command module including the MEP, the celestial sphere drive, and the illuminator and occulting assembly are:

a. Length-130.25 inches

b. Width-99.56 inches

c. Height-164.4 inches

The unit weighs approximately 2600 pounds of which the MEP accounts for 650 pounds, the celestial sphere 250 pounds, and the C/S illuminator and occulting assembly 100 pounds.

1-20. Mounting Provisions. The telescope is mounted on a supporting structure at three points located above the instrument's center of gravity. The mounting arrangement of the telescope on the supporting frame, as well as the mounting of the optical bridge within the telescope's frame assembly, is kinematic. The primary reason for the kinematic mounts is to avoid deorientation of the optical line-of-sight due to possible deflections or thermal expansion (or contraction) of the supporting frame members. The telescope frame mounts are threaded to serve as leveling screws, and each is hemispherical on the bearing end. Two mounts are located on the sides of the telescope near the front surface, and the third mount is on the vertical centerline of the rear surface. The seating brackets, attached to the supporting structure, are provided with three differently formed bearing surfaces to provide the kinematic feature. The side bracket on the right side, viewing the telescope from the rear, has a hemispherical detent in the center of the bearing surface; the left side bracket is finished with a transverse V-groove and the rear bracket is flat-surfaced.

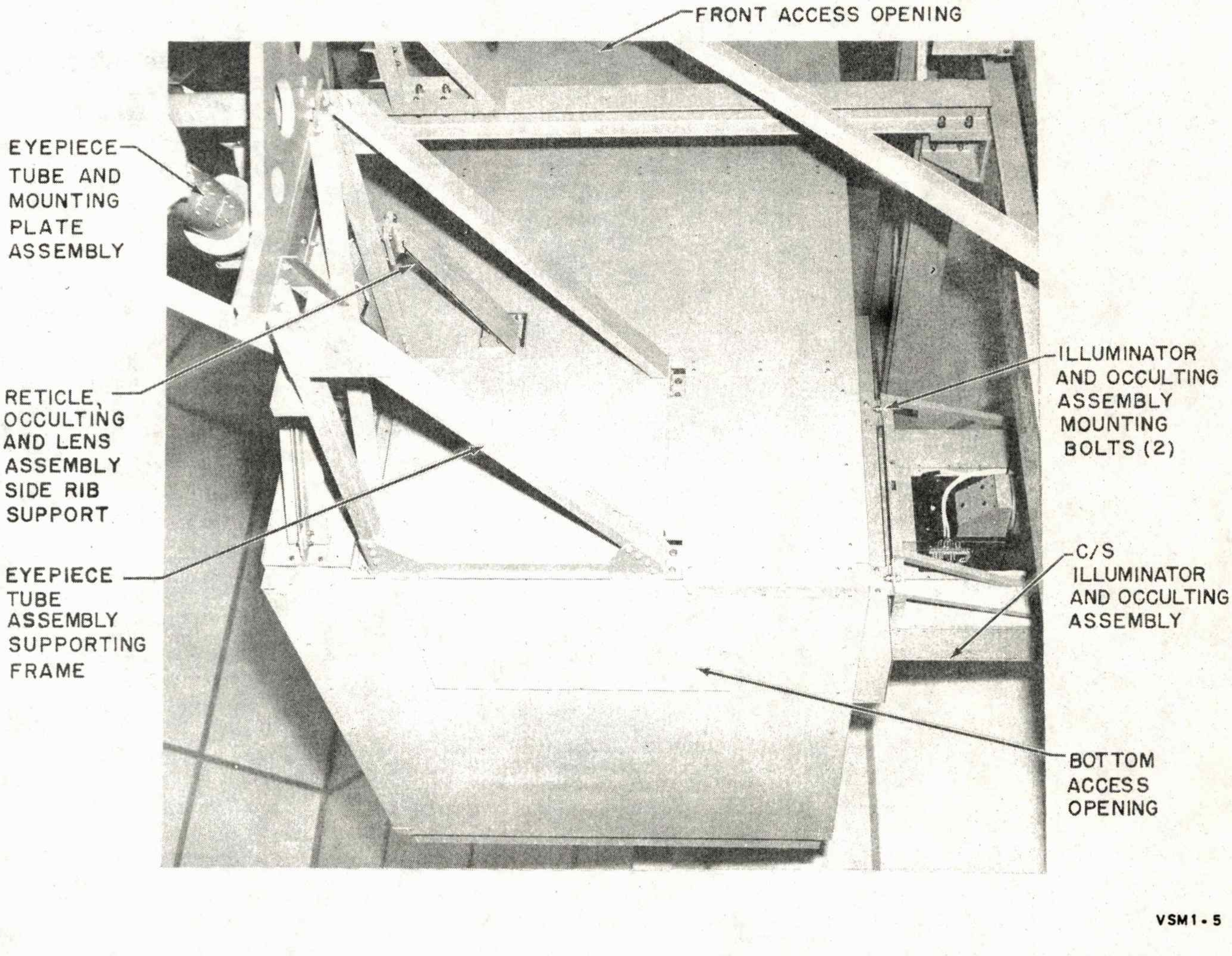

Figure 1-5. AMS Telescope, Front and Bottom View

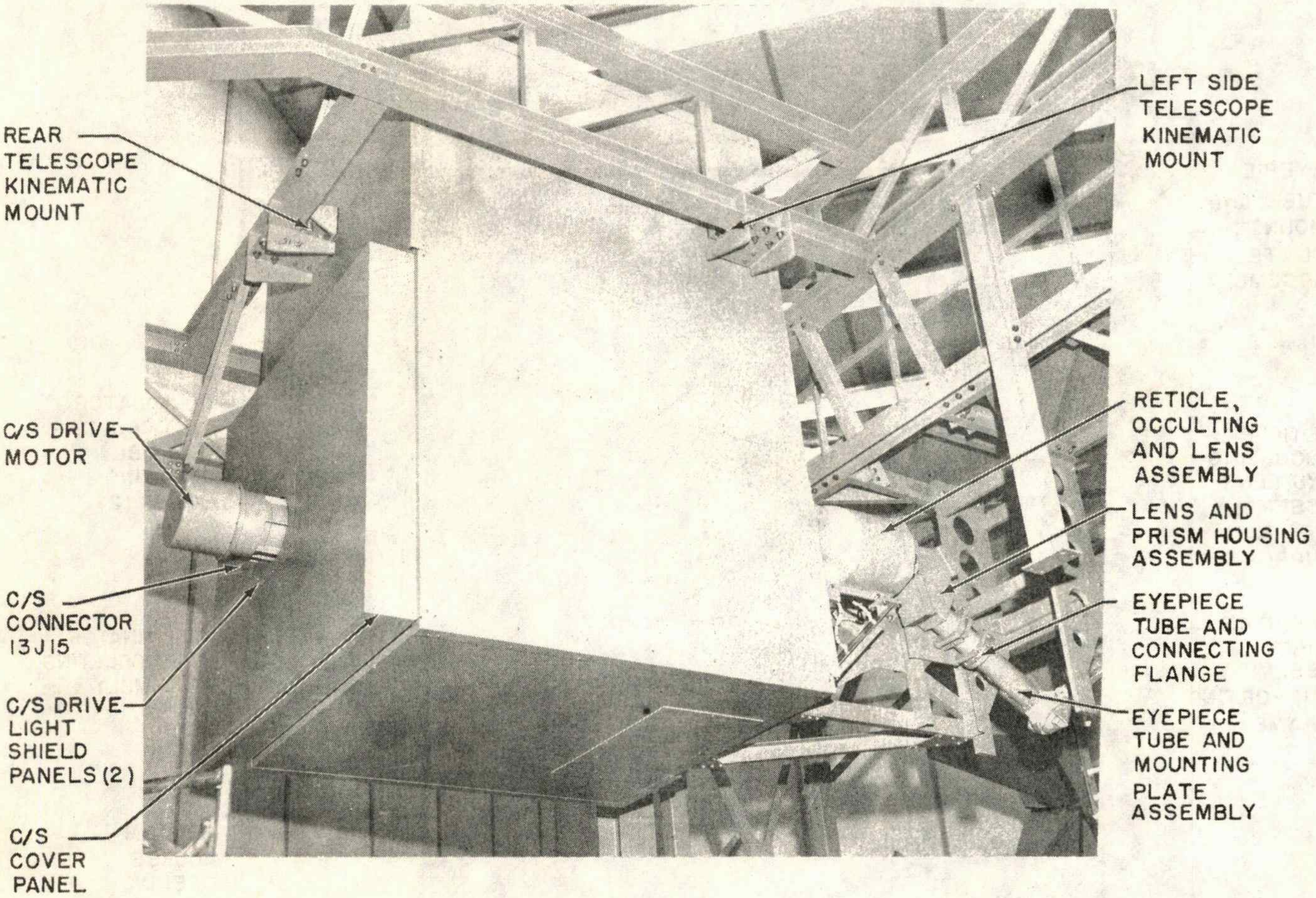

Figure 1-6. AMS Telescope, Rear and Sextant Side (Sextant Removed)

1-21. Optical Characteristics. The optical characteristics of the telescope are contained in table 1-2.

1-22. Electrical Power Requirements. The electrical power requirements for the operable and illumination assemblies, with the exception of the MEP, the C/S, and the C/S illuminator and occulting assembly, are included in table 1-3.

Table 1-2. Telescope Optical Characteristics

Item	Characteristics
Exit pupil	0.3 ± 0.05 in.
Eye relief	0.52 ± 0.03 - 0.01 in.
Effective aperture	0.3 in.
Eyepiece focal length	1.42 in.
Field of view	60^{o} Minimum
Magnification	1-Power
Resolution:	
On axis	2 arc minutes
Edge of field of view	5 arc minutes
Eyepiece focus	-1 Diopter (fixed)
Image orientation:	
Starfield	Upright and non-reversed
MEP	Upright and non-reversed
Transmission percentage:	
Starfield	2% Minimum
MEP	2% Minimum

Table 1-3. Telescope Electrical Data

Component	Type of Power	Long Cable No.	AWG Wire Size	Con- nector No.	Connector Location	Terminal Board Location	Max. Power Req'd.
C/M Occulting Assembly							
Right Blade							
Motor-Generator	36 VAC	W542	20	13J1	Bracket-mounted immediately below	C/M Occult. Mounting Plate-Rear	18W
Resolver	AC Var. (Note 1)	W542	24	13J1			(Note 2)
Left Blade					Reticle, Occulting and Lens Assembly		
Motor-Generator	36 VAC	W542	20	13J1		Same	18W
Resolver	AC Var.	W542	24	13J1		Same	
Vertical Blade							
Motor-Generator	36 VAC	W542	20	13J1		Same	18W
Resolver	AC Var.	W542	24	13J1		Same	
Rotating Reticle Assembly							
Motor	12VDC	W548	12	13J2		Reticle Mounting Plate-Front	60W
Resolver	AC Var.	W543	26	13J2			1W
Edge Lights	5 VAC Var.	W542	16	13J1			
Sunshafting Light	28 VAC	W542	16	13J1		Same	20W

Note 1 - All resolvers operate on 400 cps power.

Note 2 - The power requirement for individual resolvers is negligible; the 115-volt, 400-cps input for the complete Telescope/Sextant system is fused for 3 amperes maximum.

1-23. SEXTANT. The purpose of the sextant in the visual system is to provide training of the astronaut in the use of the guidance and navigation (G&N) system. When used in conjunction with the telescope, this training includes the use of the equipment, the choice of landmarks, and correlation of the data with the observed visual information. The sextant (unit 12) is used during specified phases of the mission to pinpoint a specific landmark after the general area is viewed through the telescope.

1-24. Sextant Major Components. Table 1-4 lists the major components of the sextant in tabular format, and also indicates the physical location of each of the assemblies in the landmark, starfield, and combined lines of sight.

1-25. Hardware Description. The sextant (see figures 1-7 and 1-8) is a completely enclosed unit that resembles two rectangular boxes mounted beside each other and on the side of the telescope. The starfield and landmark light source housing protrudes from the rear of the sextant. A casting, which houses the rotating prism assembly, projects from the front surface of the sextant. The eyepiece tube assembly projects downward to pass through a clearance hole in the command module. The eyepiece tube terminates in a mounting panel to which the removable sextant eyepiece assembly is mounted.

1-26. Overall Dimensions And Weight. The over-all dimensions of the sextant cabinet, carousel, and combined light source (figures 1-7 and 1-8), but excluding the eyepiece tube and rotating prism housing are:

a. Length - 55-1/2 inches

b. Width - 48 inches

c. Weight - 27 inches

The length of the eyepiece tube, including the rotating prism housing, to the front surface of the eyepiece mounting panel is 29 inches. The sextant weights approximately 800 pounds.

1-27. Mounting Provisions. The sextant is ridigly fastened to a suspension type structure at three points by means of capscrews threaded into tapped studs which project from the undersurface of the sextant's support frame. The structure attachments are in line with the three optical bed supporting studs, as shown in figure 1-9.

1-28. Optical Characteristics. The optical characteristics of the sextant are contained in table 1-5.

Table 1-4. Sextant Components

Nomenclature	Common Name	Specific Functions
Support Frame Assembly	Support Frame	Provides a rigid support for the optical bed (and all assemblies mounted thereon), the carousel, the combined light source, the rotating prism, the eyepiece tube, and cover cabinet.
Cabinet Assembly	Sextant Cover	Provides a light-tight, dust-free, cover for the optical bed and carousel.
Optical Bed Plate	Optical Bed	Provides a rigid, flat, mounting surface for all the assemblies in the landmark, starfield, and combined lines of sight, excepting the rotating prism, eyepiece tube, and eyepiece assembly and mounting plate.
Light Source Assembly Starfield and Landmark	Combined Light Source	Supplies light of the required intensity for both landmark scene and starfield scene. The assembly contains two lamps, two mirrors, and two exhaust fan blowers and is divided by a light-tight partition so that either line of sight may be viewed independently or simultaneously.
Carousel Assembly	Carousel	Supports the slide magazine assembly and incorporates the electromechanical rotation mechanism. The slide actuator assembly is incorporated in the carousel.
Landmark LOS		
Slide Gate Assembly	Slide Gate	Supports the landmark slide, injected from the slide magazine, on the optical bed. Contains a spring-loaded camroll mechanism that insures correct final positioning of the slide, so that the center of the scene presented is within 0.0003 in. of the true landmark line of sight.

Table 1-4. Sextant Components (Cont)

Nomenclature	Common Name	Specific Functions
Landmark Rhomb Scanning Assembly	Landmark Rhomb Scanner	Permits displacement of the optical path, by rotation of the large mirror rhomboid in conjunction with rotation of the prism rhomboid, so that any portion of the 4 degree conical angle representing the entire landmark scene can be viewed in the 1.8 degree conical angle of the sextant field of view. Another function of the scanner is to simulate yaw, pitch, and roll motion of the command module within the 0.5 deadband of stabilization when the sextant's shaft axis is centered on a landmark during a navigational sighting.
Variable Magnification Assembly	Variable Magnification	Permits varying the magnification of the landmark scene in order to simulate travel of the command module either away from or toward an earth (or moon) landmark during the navigational sighting. The range of magnification is from a maximum of $\sqrt{2}$ to a minimum of the reciprocal of $\sqrt{2}$.
Landmark Right Angle Mirror Assembly	Landmark Right Angle Mirror	Reflects the landmark scene 90 degrees in the horizontal plane towards the rotating polaroid filter.
Landmark Rotating Polaroid Filter Assembly	Rotating Polaroid	Provides varying brightness of the landmark image to duplicate the effect of the polaroid filter in the operational telescope, i.e., filter rotation introduced with change in shaft angle.

Table 1-4. Sextant Components (Cont)

Nomenclature	Common Name	Specific Functions
Starfield L.O.S.		
Starfield Generator Assembly	Starfield Generator	Presents any one of 28 star groups, each of which represents a 4 degree conical angle around one of the 28 navigational stars selected as celestial references for navigational sightings. The assembly also incorporates the light source, prism, filter wheel, and part of the light tubing that generates the navigational stars.
Starfield and Navigational Star Beamsplitter Assembly	Starfield Beamsplitter	Combine the filtered light rays representing the Navigational star and the corresponding star group scene generated by the starfield generator. The frame in which the cube beamsplitter is mounted also supports the remaining portion of the light tubing, lens, orifice, and prism of the navigational star generating system.
Starfield Rhomb Scanner Assembly	Starfield Rhomb Scanner	Provides a means for movement of the image of the navigational star (and surround) on the plane of the reticle so that the navigational star can be superimposed on the landmark image at the center of the reticle.
Starfield/Navigational Star Relay Lens Assembly	Starfield Relay Lens	Relays the navigational star (and surround) toward the starfield right angle mirror.
Starfield Right Angle Mirror Assembly	Starfield Right Angle Mirror	Reflects the navigational star (and surround) 90 degrees in the horizontal plane toward the landmark and starfield combining beamsplitter.

Table 1-4. Sextant Components (Cont)

Nomenclature	Common Name	Specific Functions
Combined LOS		
Beamsplitter Assembly	Combining Beamsplitter	Combines landmark scene and starfield scene and reflects the combined scenes toward the compound angle mirror.
Compound Mirror Assembly	Compound Angle Mirror	Reflects the combined scenes onto the reticle in the reticle. The mirror is oriented so as to deflect the combined lines of sight downward 32.5 degrees and normal to the plane of the reticle.
Rotating Reticle Assembly	Rotating Reticle	Simulates the rotation of the reticle in the operational sextant.
Rotating Prism Assembly	Rotating Prism	Simulates the rotation of the field of view as affected by the rotation of the command module, the rotation of the earth, and command module attitude.
Eyepiece Tube Assembly	Eyepiece Tube	Provides a light-tight path for the line of sight from the rotating prism to the eyepiece at the Astronaut's navigation station in the command module. The eyepiece tube houses a relay lens assembly which relays the image from the plane of the reticle to the focal plane of the eyepiece.
Eyepiece Mounting Panel Assembly	Mounting Panel	Duplicates the eyepiece mounting panel of the operational sextant, and provides a support for the removable eyepiece.

Table 1-4. Sextant Components (Cont)

Nomenclature	Common Name	Specific Functions
Sextant Eyepiece Assembly	Eyepiece	Duplicates the appearance of the operational sextant's eyepiece. Permits viewing the combined landmark image and starfield image in the focal plane of the eyepiece. The eyepiece is provided with focusing adjustment of plus or minus two diopters, and also contains a manually rotated polaroid analyzer, used in conjunction with the rotating polaroid.

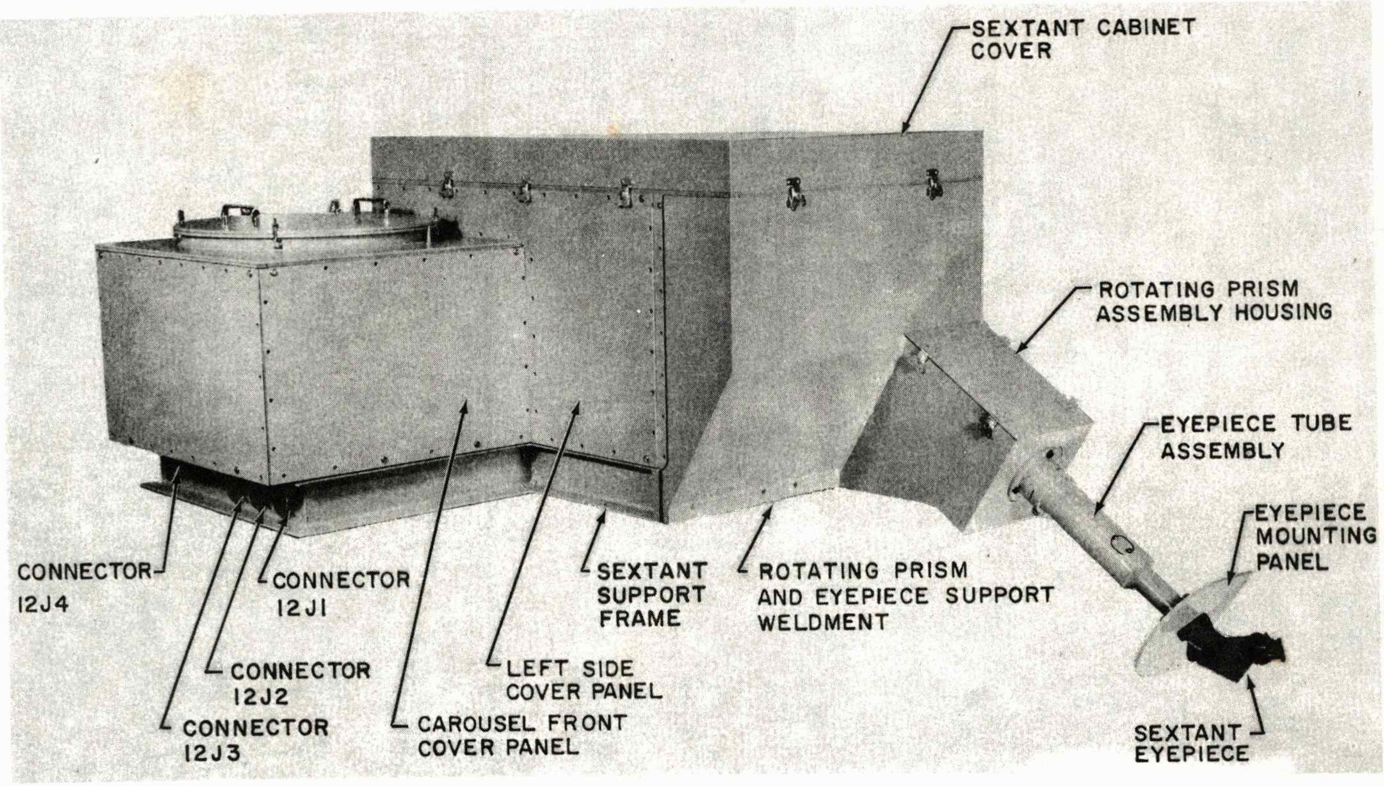

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Figure 1-7. AMS Sextant, Front and Carousel Side

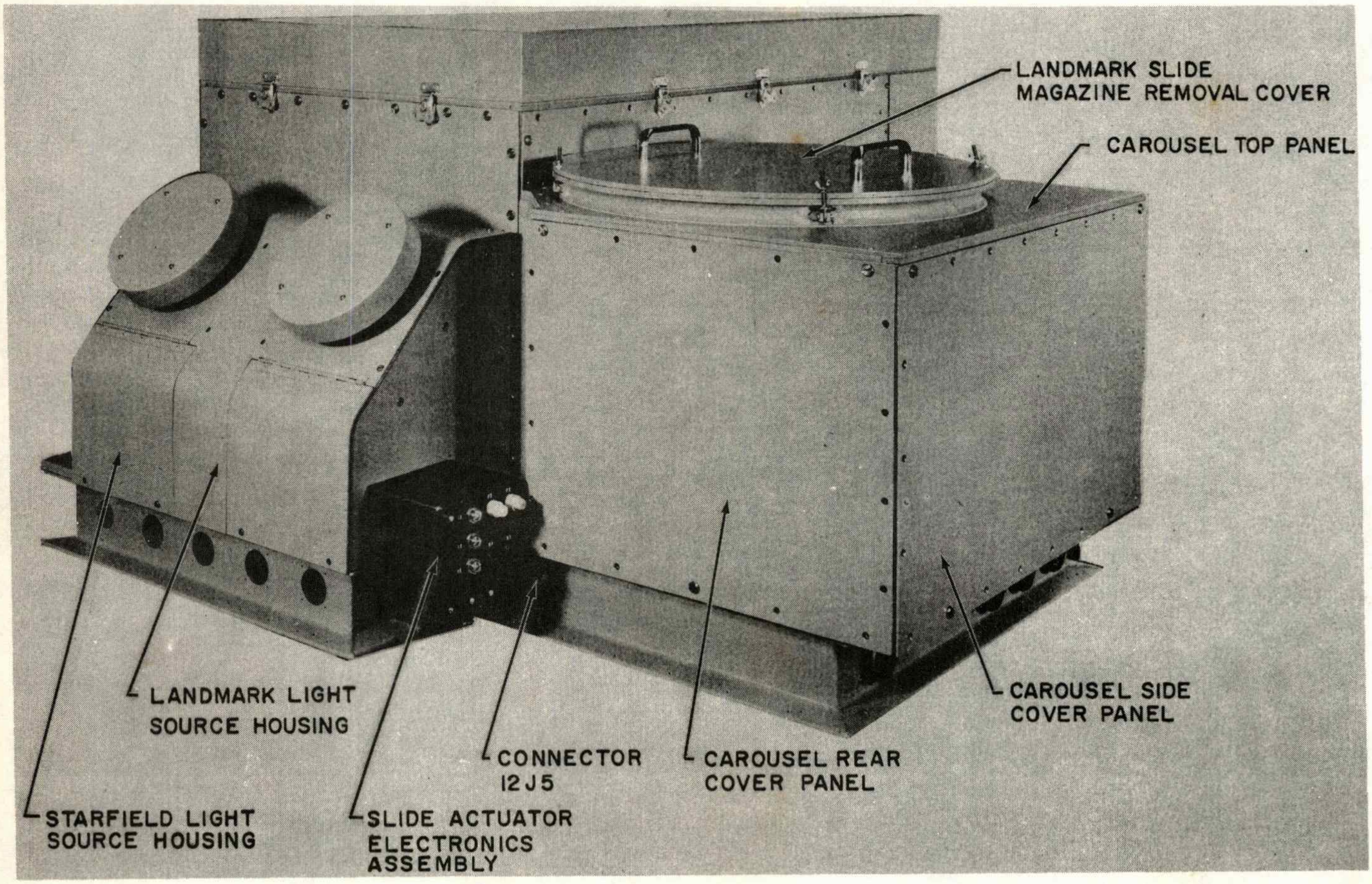

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Figure 1-8. AMS Sextant, Rear View

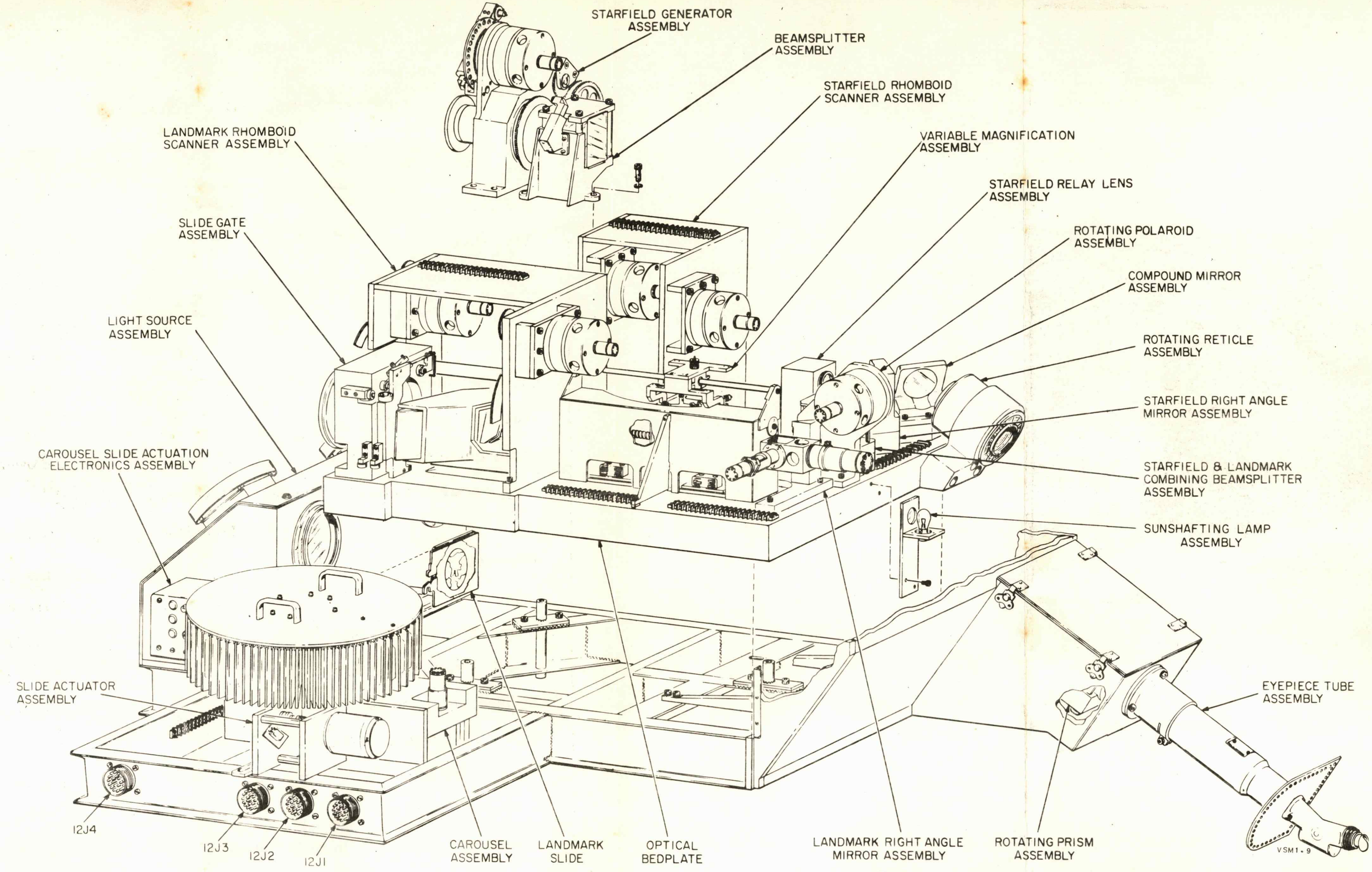


Figure 1-9. Sextant Internal Arrangement

Table 1-5. Sextant Optical Characteristics

Item	Characteristics
Exit pupil	0.06 inch
Eye relief	0.875 inch
Eyepiece focal length	1.1 inches
True field of view	1.8 degrees
Apparent field of view	47.5 degrees
Magnification (simulated)	28-Power
Magnification (true):	
Starfield line of sight	1-Power
Landmark line of sight (variable) - Maximum	$\sqrt{2}$
- Minimum	$1/\sqrt{2}$
Resolution:	
On axis	5 arc seconds
At 1/3 field, better than	10 arc seconds
At 2/3 field, better than	15 arc seconds
Eyepiece focus (adjustable)	±2 diopters
Object and image area diameters:	
Landmark scene	4.45 inches
Starfield scene	3.15 inches
Superimposed images in reticle plane	1.42 inches
Brightness, as seen through the eyepiece	10 fl (open gate)

1-29. Electrical Power Requirements. The power requirements and other electrical data for the operable assemblies and illumination in the sextant are listed in table 1-6.

1-30. TELESCOPE/SEXTANT ELECTRONICS CABINET. The telescope/sextant electronics cabinet (unit 9) provides all the electronics required by the simulated telescope and sextant during a simulated mission and during test operations. This cabinet contains switching circuits which select automatic or manual servo command signal application and digital to resolver converter (DRC) logic which converts two of the computer input signals from digital to analog quantities. It also contains servo amplifiers, which amplify resolver error signals for motor drive, and manual controls, which regulate all required signals during testing and supply and control all necessary a-c and d-c power.

1-31. Electronics Cabinet Major Components.. Table 1-7 lists, in tabular format, the major components housed in the electronics cabinet.

Table 1-6. Sextant Electrical Data

Component	Type of Power	Long Cable No.	AWG Wire Size	Electrical Connector Designation	Maximum Power Required
Combined Light Source Landmark and Starfield					
Lamps (2)	115 VAC	W538	16	12J1	150 W ea
Fans (2)	115 VAC	W538	16	12J1	14 W ea
Navigational Star Light	6 VDC				4.5 amp
Carousel Assembly					
Motor-Generator	36 VAC	W538	20	12J1	18W
Resolver	See Note 1	W538	24	12J1	See Note 2
Slide Actuator Assembly					
Electronics Unit	±28 VDC	W538	14	12J5	1.0 amp
	-12 VDC	W538	18	12J5	0.25 amp
Slosyn Motor	115 VAC	W538	18	12J5 See Note 3	20 W
Landmark Rhomb Scanner					
α Servo Motor	12 VDC	W540	12	12J3	60 W
32X Resolver	AC Var	W540	24	12J3	
1X Resolver	AC Var	W540	24	12J3	
β Servo Motor	12 VDC	W540	12	12J3	60W
32X Resolver	AC Var	W540	24	12J3	
1X Resolver	AC Var	W540	24	12J3	
Variable Magnification Assembly					
Motor-Generator	36 VAC	W538	20	12J1	18W
Resolver	AC Var	W538	24	12J1	

Table 1-7. Telescope/Sextant Electronic Cabinet Major Components

Nomenclature	Common Name	Specific Function
Test Panel	test panel	Testing servos
Single-Speed Director Assemblies	duming director	Driving servos manually
Dual-Speed Director Assemblies	2 speed dummy director	Driving servos manually
Test Panel Assembly Chassis	chassis	Mount dummy directors and associated equipment
Relay Subassembly Chassis	relay chassis	Logic and DCE interface
Power Control Panel	power panel	Used to apply power to system
D-C Power Supplies	DC power supplies	Supplies ±24V to system
A-C Servo Amplifier Assemblies	AC amplifiers	Drives ac servos
D-C Torque Motor Electronic Assemblies	DC amplifiers	Demodulates ac error signal and drives d.c. servos
Carousal Slide Actuation Electronics Assembly	carousal electronics	Drives carousal slide assembly

1-32. Hardware Description. The electronics cabinet is divided into two major sections which are separated by a ventilation duct. The two sections are the test and power control section and the servo control section.

1-33. Test and Power Control Section. The test and power control section, which is the left bay, contains the test panel, the power control assembly, and the necessary d-c power supplies. The servo control section, which is the right bay, contains 16 shelf-mounted assemblies consisting of: 5 a-c servo amplifier assemblies, 10 d-c torque motor electronics assemblies, and a power failure assembly. Each shelf contains three assemblies, the names of which are printed on the front of the shelf. Figure 2-1 denotes the location of each of these assemblies.

1-34. The test panel (see figure 2-2) contains all of the manual controls required for testing the telescope and sextant system servo loops. The test panel face is divided into 15 individual sections, each of which is associated with a particular servo loop. Each section is marked with the name of the servo loop with which it is associated.

1-35. The top row contains six sections. Five of these sections are used to test the single speed servo loops consisting of: the sextant starfield rotation servo, sextant reticle servo, the sextant rotating prism servo, the sextant polarizer servo, and the telescope reticle servo. The remaining section is used as a spare. Each section contains one TEST/NORM toggle switch, a resolver director control knob and dial, and one set of test jacks. The TEST/NORM toggle switch is used to place the associated servo loop under computer or manual control. The resolver director control knob, which is mechanically connected to a resolver in the single speed director assembly behind the panel, is used to manually introduce command signals into the servo loop. The test jacks are circuit test points which are used to monitor error voltage behavior within the servo loop during testing.

1-36. The second row contains four sections that are used to test a-c servo loops consisting of the sextant variable magnification servo, the telescope vertical occulting servo, the telescope left occulting servo, and the telescope right occulting servo. Each section contains one TEST/NORM toggle switch, a resolver direction control knob and dial, and two sets of test jacks. The TEST/NORM toggle switch is used to place the associated servo loop under computer or manual control. The resolver director control knob, which is mechanically connected to a resolver in the single speed director assembly behind the test panel, is used to manually introduce command signals into the servo loop, The test jacks are circuit test points that are used to monitor error and tachometer voltage behavior during testing.

1-37. The third row contains three sections. Two of these sections are used to test two speed d-c servo loops consisting of the sextant starfield scanner servo and the sextant landmark scanner servo. The other section is used to test the sextant slide selector servo, and the a-c servo loop. Each of the two speed servo loop sections consists of a TEST/NORM toggle switch, a resolver director control knob, and two sets of test jacks. The TEST/NORM toggle switch is used to place the associated servo loop under computer or manual control. The resolver director

control knob, which is mechanically connected to the dual speed director behind the test panel, is used to manually introduce error signals into the servo loop. The two sets of test jacks, consisting of a 1x set and a 32x set, are electrically connected to the servo loop and are used to monitor the behavior of the respective error voltages during test. The a-c servo loop section contains a TEST/NORM toggle switch, two sets of test jacks, and two rotary selector switches. The TEST/NORM toggle switch is used to place the associated servo loop and DRC circuitry under computer or manual control. The two selector switches are used to control the binary coded decimal (BCD) input to the associated DRC circuitry. The lower switch controls the tens portions of the BCD value; the upper switch controls the units portion. The two sets of test jacks, consisting of a TACH set and an ERROR set are electrically connected to the servo loop and are used to monitor the behavior of the respective voltages during testing.

1-38. The fourth row contains three sections. Two of these sections are used to test two-speed d-c servo loops consisting of the sextant starfield scanner servo and the sextant landmark scanner servo. The other section is used to test the sextant slide selector single-speed d-c servo loop. The controls in the two-speed d-c sections are identical to those described in the preceding paragraphs. The single-speed d-c section contains a TEST/NORM toggle switch, an EVEN/ODD toggle switch, a set of ERROR test jacks, and rotary selector switch. The TEST/NORM toggle switch is used to place the loop under computer or manual control. The rotary selector switch is used in conjunction with the EVEN/ODD toggle switch to generate a desired BCD input signal for the loop. The ERROR test jacks are electrically connected to the servo loop and are used to monitor the behavior of the error voltage during testing.

1-39. Two single-speed director assemblies are mounted behind the test panel. Each assembly is attached to a mounting plate which is secured to the rear surface of the test panel by means of four machine screws. One assembly contains five resolvers and the associated control knob and dial assemblies, and the other assembly contains four. Each resolver is fastened to a mounting plate by means of three machine screws. These resolvers are used for manually generating command signals in the servo loops associated with the nine sections in the top two rows of the test panel.

1-40. Two dual speed director assemblies are mounted behind the test panel. Each assembly consists of a mounting plate, four resolvers, a control knob and dial set, and associated gearing. The mounting plate, secured to the rear surface of the test panel by means of four machine screws, supports the resolvers and associated gearing. Each resolver is fastened to the mounting plate by three machine screws.

1-41. The shaft of the low-speed (1x) resolver is geared to the shaft of the high-speed (32x) resolver to provide the required characteristics of a two-speed signal. The control knob is attached to the high-speed resolver so that when it is rotated 32 times, the low-speed resolver is rotated once.

1-42. The rest panel assembly chassis contains 12 transformers, 4 terminal boards, and 6 connectors. The chassis is fastened to the rear surface of the test panel by four machine screws.

1-43. The transformers are the starfield reference transformer, the carousel reference transformer, the starfield compensation transformer, and the step down transformers. The starfield and carousel reference transformers are components of the DRC's associated with the respective servos. These transformers are tapped to provide the necessary range of sine and cosine voltages required to define the required positions for the starfield and carousel respectively. Step-down transformer T1 supplies 400-cycle reference voltage to the rotor windings of the test panel resolvers. Step-down transformer T2 supplies 400-cycle voltage to the DRC transformers.

1-44. The four terminal boards consisting of 9A1TB1 through 9A1TB4 handle power and signal distribution for the carousel and starfield DRC's. The six connectors consisting of 9A1J1 through 9A1J6 handle power and signal distribution between the test panel circuitry and the rest of the system.

1-45. The relay subassembly chassis is mounted directly beneath the test panel chassis. This chassis contains 22 telephone-type relays which are associated with the landmark and starfield DRC's.

1-46. The power control panel (see figure 2-5) contains the manual controls and associated indicators that are used for the application and regulation of power. The nomenclature of each control and indicator is marked on the panel face, and the purpose of each is summarized in table 2-5. The panel is secured to the vertical mounting rails by means of four machine screws.

1-47. Behind the power oontrol panel are mounted a double-pole, single-throw toggle switch, six relays, an RC network consisting of two capacitors and two resistors, four terminal boards, and two connectors. Relays labeled K1, K2, and K3 are used in the variable intensity control circuit for landmark illumination intensity. Relay K4 is a time delay relay used to apply 115-volt 400-cycle power to the system. Relays K5 and K6 connect illumination power to the telescope and sextant sunshafting lamps respectively. The double-pole, single-throw toggle switch at the rear of the chassis is used for manual ON/OFF control of the telescope and sextant sunshafting lamps.

1-48. D-C Power Supplies. Four d-c power supplies are installed in the telescope/sextant electronics cabinet. Information concerning the power supplies is contained in paragraph 1-378. See figure 2-1 for a complete listing of controls and their functions.

1-49. A-C Servo Amplifier Assemblies. Five identical a-c servo amplifier assemblies are installed in the electronics cabinet. Each assembly is constructed as a replaceable module consisting of an enclosure which contains a printed circuit card assembly, a terminal board, a fuse post and connector

assembly, and associated electronic components. Mounted on the amplifier enclosure are four output stage transistors and the output transformer. The printed circuit card contains all of the circuitry for the three a-c preamplifier stages and the gain potentiometers for the error and tach signals.

1-50. D-C Torque Motor Electronics Assemblies. Ten d-c torque motor electronics assemblies are installed in the electronics cabinet. Each assembly is constructed as an individual module which is secured to a shelf mounted chassis. Each consists of an enclosure, two printed circuit card assemblies, and the associated electronic components. The circuitry for each of these assemblies is the same except for the capacitor portion of the RC phase lead compensation network. This capacitor is externally mounted and its value is different for each assembly. Six transistors, which comprise the output stages for the d-c power amplifier circuitry, are mounted on the amplifier enclosure; the other components are mounted on the printed circuit cards.

1-51. The printed circuit cards associated with the d-c torque motor electronics assembly consist of the a-c amplifier, demodulator, and compensator card assemblies and the d-c preamplifier card assembly. The a-c amplifier, demodulator, and compensator card assembly contains the input switching circuitry for single-speed and two-speed applications, a protective limiter, the GAIN potentiometer, four transistorized amplifier stages, and the transformers and diodes which comprise the phase sensitive demodulator portion of the circuitry. The d-c preamplifier card contains the resistor portion of the RC phase lead network, the DC BALANCE potentiometer, and three transistorized amplifier stages.

1-52. Carousel Slide Actuation Electronics Assembly. The carousel slide actuation electronics assembly contains a printed circuit card assembly, a relay mounting block assembly, and a connector assembly. This assembly is installed on the AMS sextant but is discussed here since it contains electronic circuitry which is controlled from this cabinet.

1-53. Two push-button switches, three indicators, and two fuses are mounted on the top surface of the amplifier enclosure. The switches, consisting of a SLIDE RETRACK and SLIDE INJECT switch, are used during test to manually control slide removal and insertion, and to permit slide magazine change. The indicators consist of a SLIDE INJECTED indicator, a SLIDE RETRACTED indicator, and a MAG REMOVED indicator. The SLIDE INJECTED and SLIDE RETRACTED indicators glow in accordance with the condition of the associated pushbutton switches. The MAG REMOVED indicator glows when the carousel magazine cover is removed.

1-54. The printed circuit card assembly contains all of the circuitry associated with the amplifier portion of the carousel slide actuation electronics assembly. This amplifier is basically a dual channel type, with each channel containing four

transistorized stages and the associated circuitry. Also mounted on the card is the logic circuitry used to control the status of the slide actuation relay. The card is mounted inside slotted tracks which are part of the amplifier enclosure.

1-55. Overall Dimensions and Weight. The overall dimensions of the electronics cabinet are:

a. Depth - 25 inches

b. Width - 48 inches

c. Height - 80 inches

d. Volume - 55.5 cubic feet

1-56. Electrical Power Requirements. The electrical power required for the assemblies in the cabinet are:

a. Single phase

  (1) Voltage - 120 volts

  (2) Frequency - 400 cps

  (3) Current - 3 amps

b. Three phase

  (1) Voltage - 120 volts

  (2) Frequency - 60 cps

  (3) Current - 10 amps per phase

1-57. OUT-THE-WINDOW DISPLAYS.

1-58. The simulated command module (SCM) contains five windows, as in the actual spacecraft; each window, with the exception of the hatch window, is equipped with an "out-the-window, infinite-distance" type of visual display. The displays are capable of earth, lunar, and starfield presentations, rendezvous and docking with the target module. The visual equipment provides presentations that appear to vary in distance from five feet (the docking presentations) to infinity (the starfield presentations).

1-59. Four of the five SCM windows are equipped with similar infinity image systems for out-the-window viewing. The left-and right-hand windows (numbered 1 and 5) have landing effects displayed, and the visual equipment is

composed of a mission effects projector with the proper film strip, a celestial sphere (starfield) unit, a sun shafting unit, and the necessary optical train.

1-60. The adjacent two windows (numbered 2 and 4) are equipped with a visual display which is capable of depicting the rendezvous and docking portions of the mission, as well as containing a celestial sphere unit, a sun shafting unit, a mission effects projector with appropriate film, the required optical train, and the necessary drive units and hardware to implement the equipment.

1-61. The visual generating equipment utilizes beam splitters and spherical mirrors to superimpose the various displays for true-to-life presentations. Each display also has an occultating system to prevent viewing one display through another, such as seeing the starfield through the target model. Cloud generation equipment is also utilized to obscure portions of the earth's surface during earth orbit.

1-62. Each window display appears to be a collection of rectangular boxes mounted at various angles to each other. Each display rests on an open, steel framework with adjustable legs.

1-63. RENDEZVOUS AND DOCKING WINDOWS. The rendezvous and docking window displays are a three input infinity projection system. Resolution of the display is limited only by the human eye and/or the image generator (the resolution of the TV-generated image is limited by the raster of the television screen). The window display is capable of presenting all necessary views for a complete rendezvous and docking mission. Figure 1-10 illustrates the physical location of the various optical assemblies and figure 1-11 provides an optical schematic of the R&D window.

1-64. Mechanical Features And Functions. The mechanical mounting of the small aperture optical elements shown with dashed lines on figure 1-12, are conventional "hard mountings" and not subject to routine maintenance operation. The remaining spherical mirrors and beamsplitters are mounted within special pneumatic mountings. There are two distinct types of pneumatic mountings provided: beamsplitter mountings and mirror mountings. The features and functions of two distinctive pneumatic mountings, the associated manifold assembly, and the mechanical mountings are described in the following paragraphs.

1-65. Beamsplitter Mounting. The mounting of beamsplitters No. 1, 4, 5 and 6 (see figure 1-10) are identical to that of the beamsplitter illustrated in figure 1-13. The details of this type mounting include the beamsplitter, a compression tube assembly, a corkprene line, a spline, and a spline screw. The edge of the beamsplitter is mounted above the spline screw.

1-66. The ten psig air pressure within the compression tube presses the beamsplitter tightly against the corkprene liner. The corkprene liner, mounted on the spline screw, supports the weight of the beamsplitter and the force applied by the

compression tube. Clockwise rotation of the spline screw lifts the beamsplitter against the compression tube assembly. The compression tube assembly is coupled to the manifold to maintain the ten psig air pressure within the tube. Operation of the manifold for adjustment of the compression tube air pressure is covered in Section VI. The C/S beamsplitter mounting features described are representative of the mounting features common to all beamsplitters.

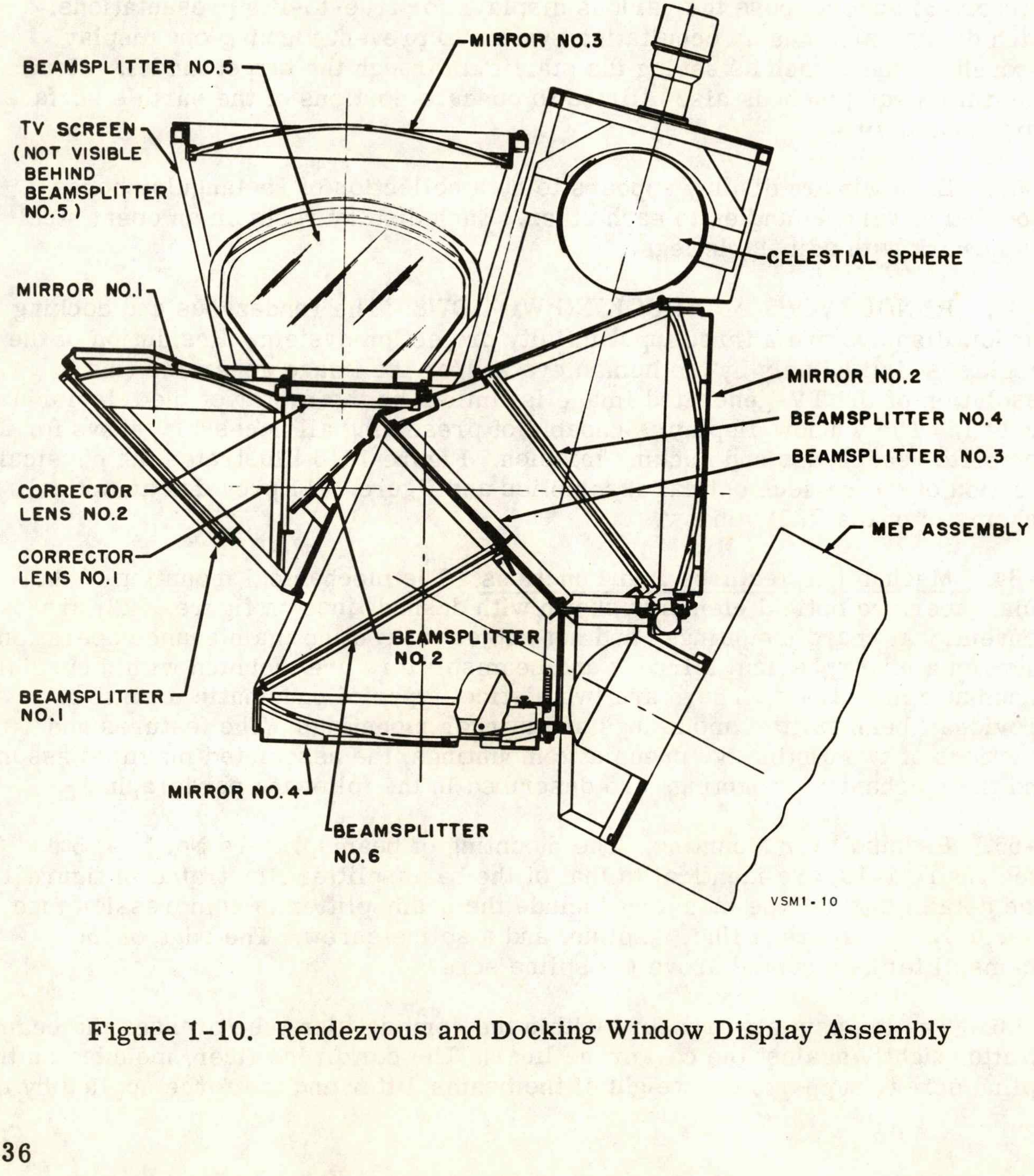


Figure 1-10. Rendezvous and Docking Window Display Assembly

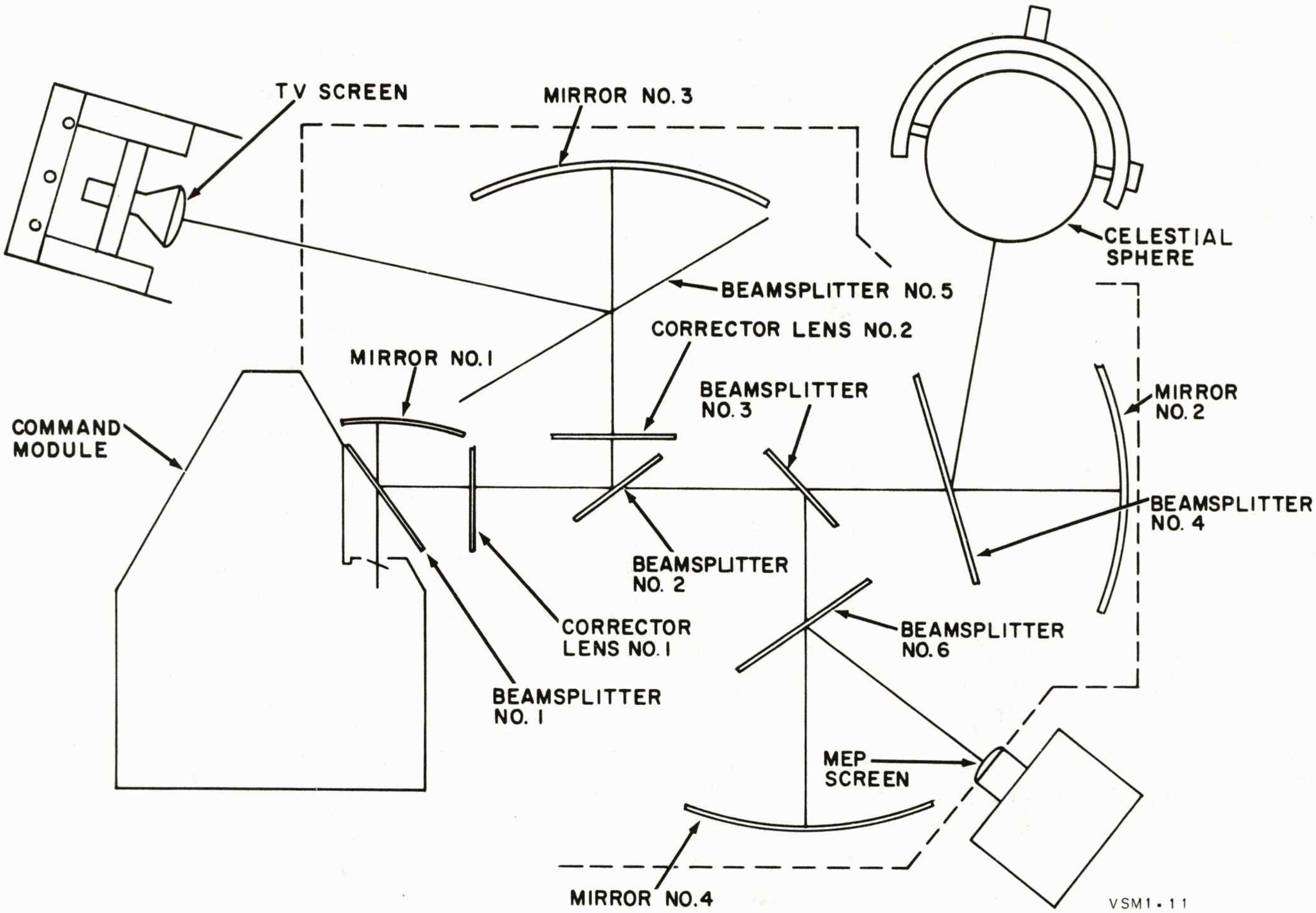


Figure 1-11. Optical Schematic-Rendezvous and Docking Window Display System

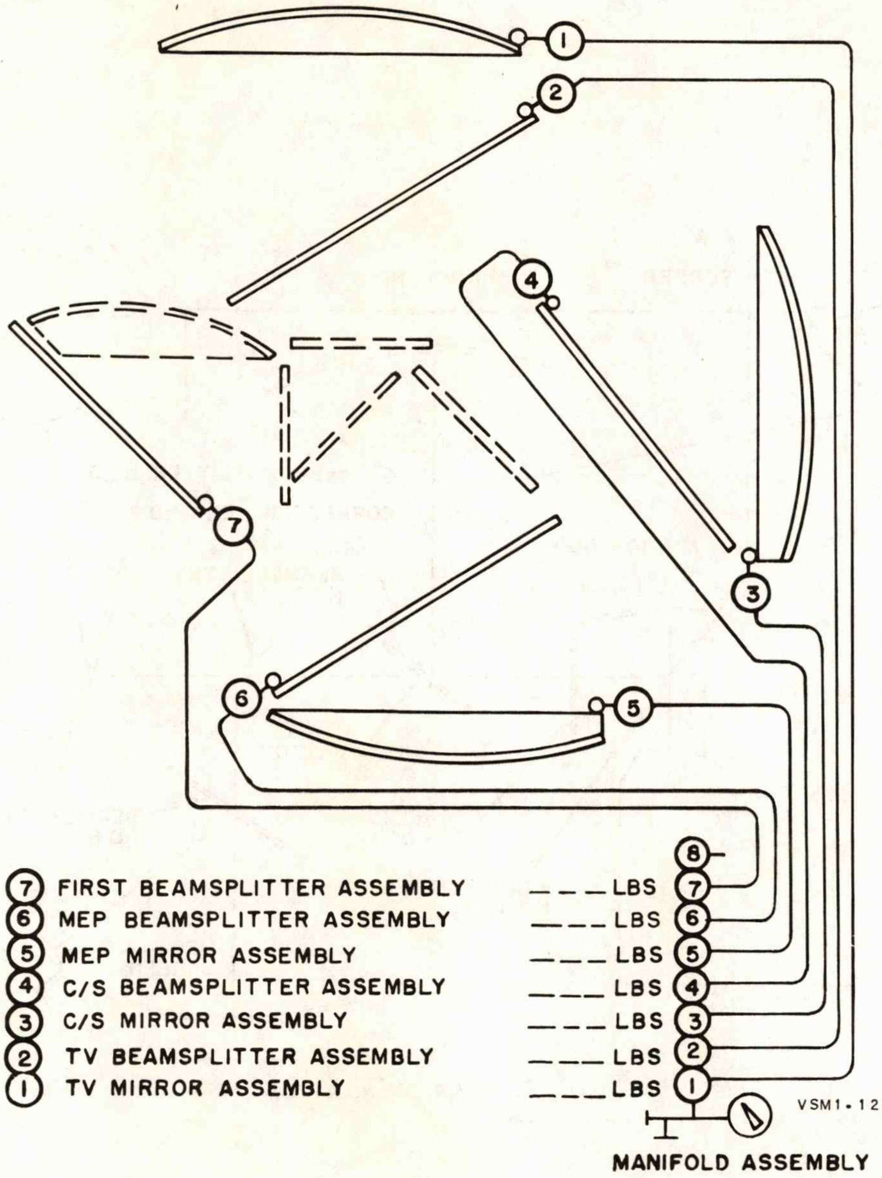


Figure 1-12. Typical Air Tube Schematic (R and D Window Shown)

1-67. Mirror Mounting. Figure 1-14 shows the mounting of spherical mirrors and illustrates the mirror, the compression tube assembly (air at 10 psig), and the quarter inch neoprene tubing.

1-68. The 10 psig air pressure within the compression tube presses the mirror tightly against the lower neoprene tubing. The neoprene tubing supports the weight of the mirror (and force applied by the compression tube) through the rigidity of its quarter-inch thick walls (no compressed air being present in the lower neoprene tubing).

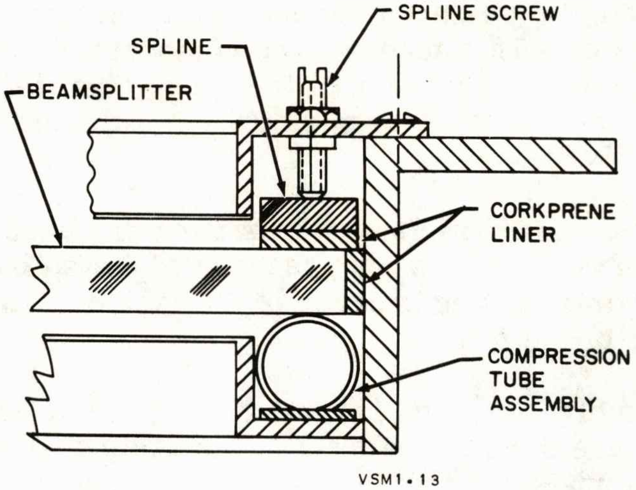


Figure 1-13. Beamsplitter Mounting

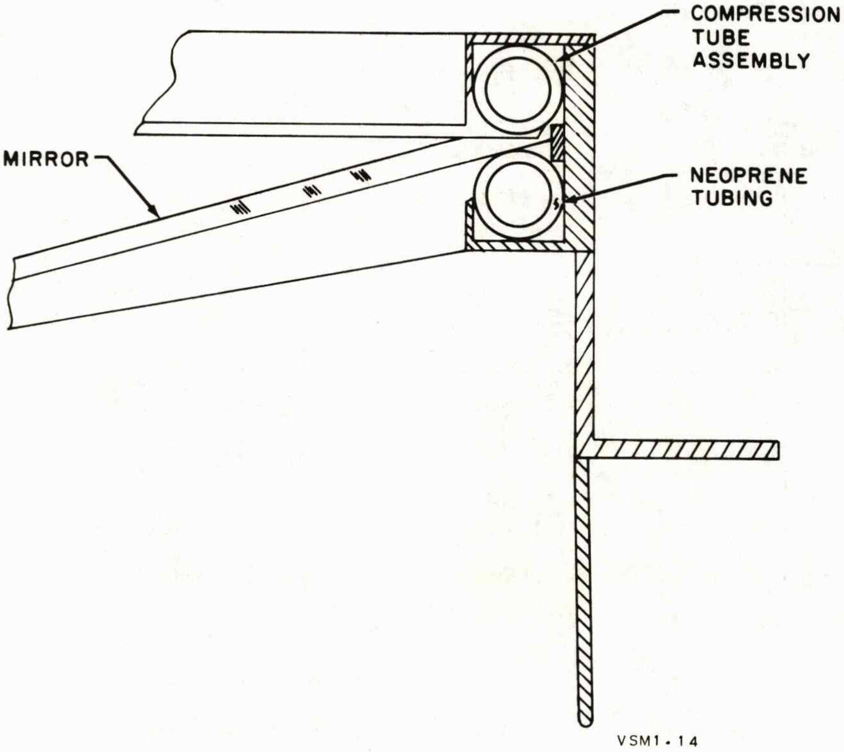


Figure 1-14. Mirror Mounting

1-69. The mirror mounting features include a quarter-inch thick-walled rigid-rubber lower tube cushion. This tube may be compressed upon increment of the manifold supplied ten psig air pressure of the upper compression tube. The compression tube assembly may be coupled to one of the eight separate receptacles of the manifold assembly.

1-70. A major difference in the beamsplitter mounting assembly with respect to the mirror mounting assembly is the presence of the spline screw. This is omitted from the mirror mounting because of the lack of parallelism between the front and back surface of the mirror.

1-71. Manifold Assembly. (See figure 1-15). All pneumatically mounted beamsplitters and mirrors are mounted below a pneumatic compression tube. The compression tube is connected by a metallic, finger-tightened nut to the plastic ferrule of the Poly-Flo tubing. This is, in turn, attached by a metallic, finger-tightened nut of the manifold assembly to one of the eight valves of the assembly.

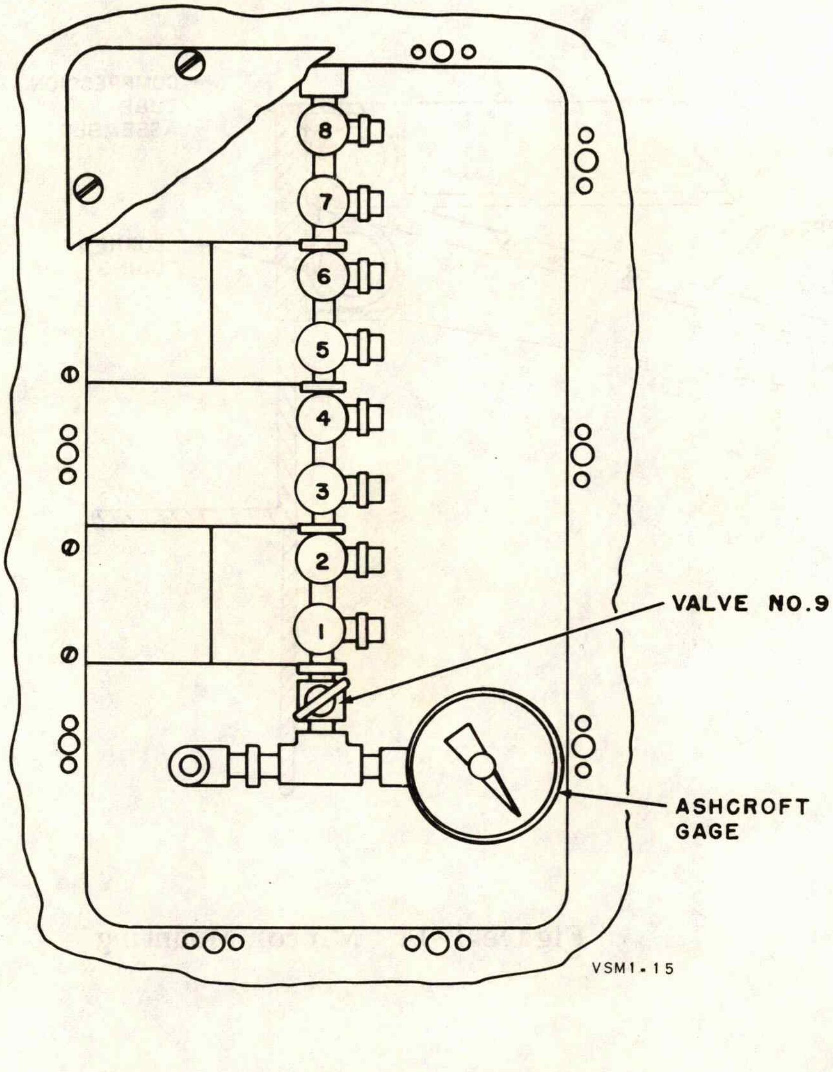


Figure 1-15. Manifold Assembly

CAUTION

> The nuts must be closed only finger tight. Use of a wrench will crush the plastic ferrule of the Poly-Flo tubing.

The manifold assembly is designed to maintain a pressure of 10 psig within the compression tube.

1-72. The manifold assembly is composed of four major items including three types of valves and a pressure gage. All valves are normally closed and the Ashcroft gage should read zero psig. The valve at the base of the assembly mates with the exhaust valve of a normal bicycle pump. Means are provided for monitoring and adjusting the pressure within any particular pneumatic tube in accordance with procedures given in Section VI.

1-73. Window Mounting Features. The support assembly used for the mounting of the window and its three image generators is comprised of a three point mounting system. The elevation of each point (with respect to the capsule window) is subject to rotation of a handwheel located at the base of the leg. (See figure 1-16).

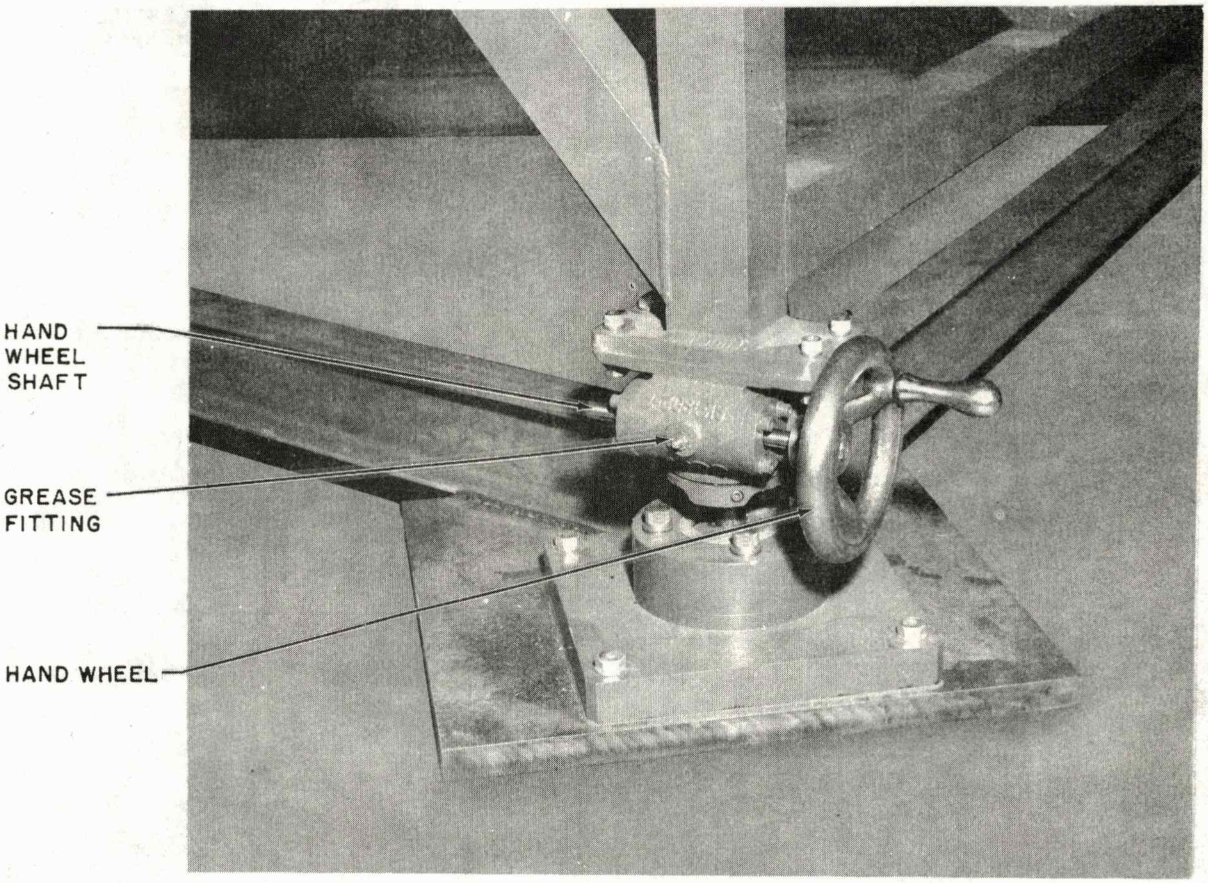


Figure 1-16. Window Assembly Elevation Hand Wheel

1-74. LANDING WINDOWS: The landing window displays are a two input infinity projection system. As with the rendezvous and docking window displays, the resolution is limited only by the human eye. The window displays include all of the views required for a full landing simulation with earth and moon occulting. The basic principles employed in the landing window displays are identical to those used in the rendezvous and docking window displays. An optical schematic of the landing window is included in figure 1-17 for reference, while figure 1-18 provides the physical location of the various optical assemblies.

1-75. CELESTIAL SPHERE (C/S). The celestial sphere realistically simulates the starfield as seen by the astronaut. It consists of a 27 inch diameter sphere whose black surface is set with 998 highly reflective bearing balls. Each of these bearing balls acts as an optical analog of a particular star of the true celestial sphere. Illumination branching from the point source of illumination into contact with the black surface of the sphere is absorbed. Illumination coming in contact with the reflecting balls, however, is reflected and spreads out (as by a convex spherical mirror) to form a virtual image of the point source of illumination.

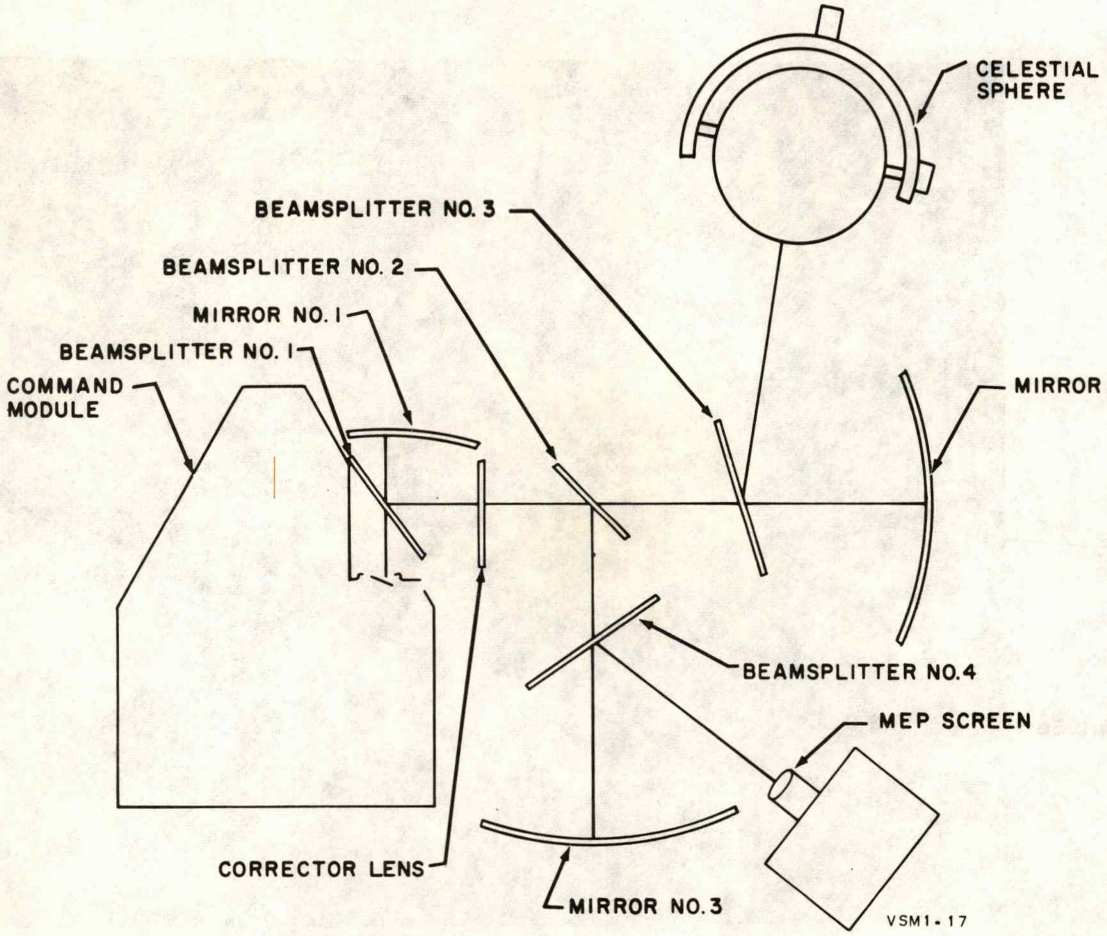


Figure 1-17. Optical Schematic - Landing Window Display System

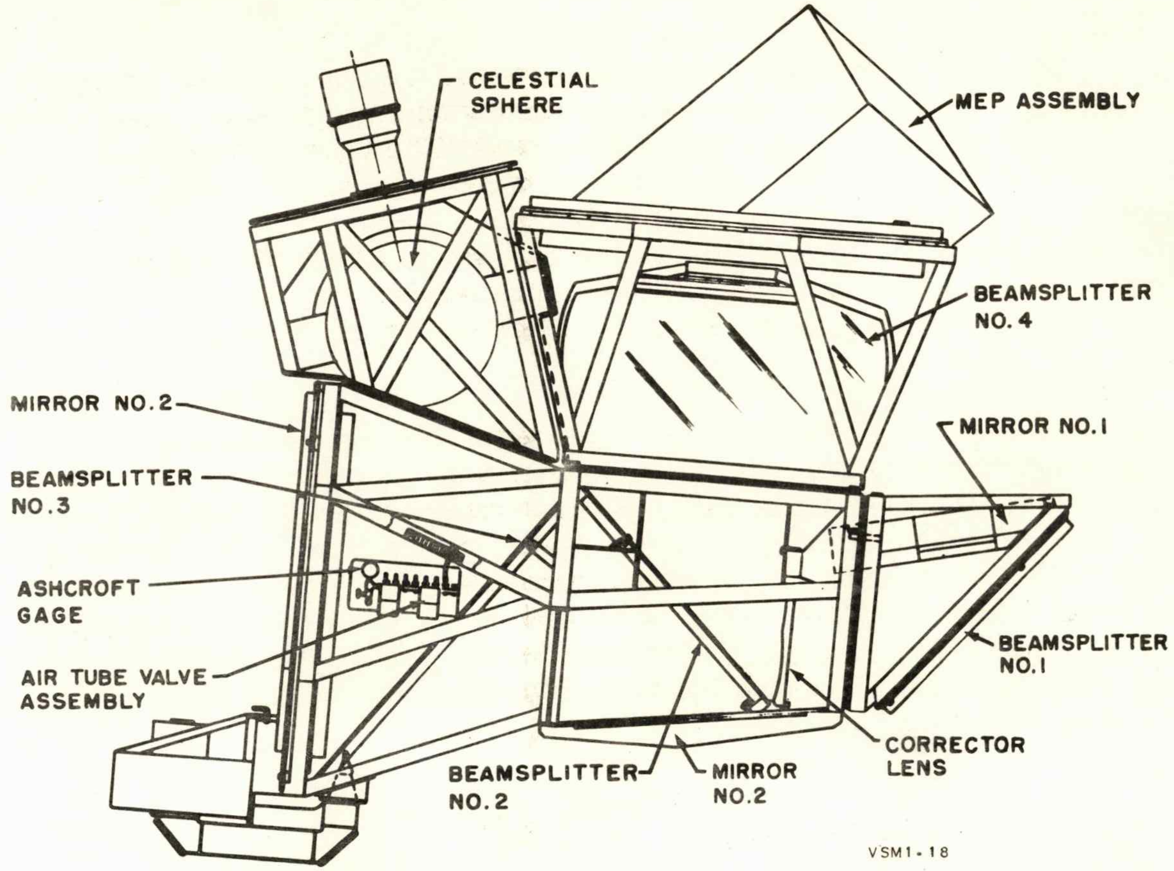


Figure 1-18. Landing Window Display Assembly

1-76. Minification and collimation of the virtual image by the window optical system provides the parallax free star images. These images appear to be arranged about the interior surface of an infinitely distant, observer-centered black sphere. The intensity of the image is proportional to the cross sectional area of the reflecting bearing ball. The range of bearing ball diameters provides intensity differences appropriate to the simulation of the 998 stars. These include the navigational stars, all stars through the fourth magnitude, and selected stars through the fifth magnitude. Individual star images are located within a positional tolerance of one milliradian (3.4 minutes of arc). Parallax is undetected upon movement of the observer's head throughout the entire exit pupil diameter.

1-77. Celestial Sphere Major Components. Figure 1-19 shows the major components of the celestial sphere. There are three servo systems which control the movement of the C/S.

1-78. Celestial Sphere Servo Systems. The celestial sphere servo systems described in the succeeding paragraphs rotate the celestial sphere in three degrees of freedom. This movement of the sphere, with respect to the cone

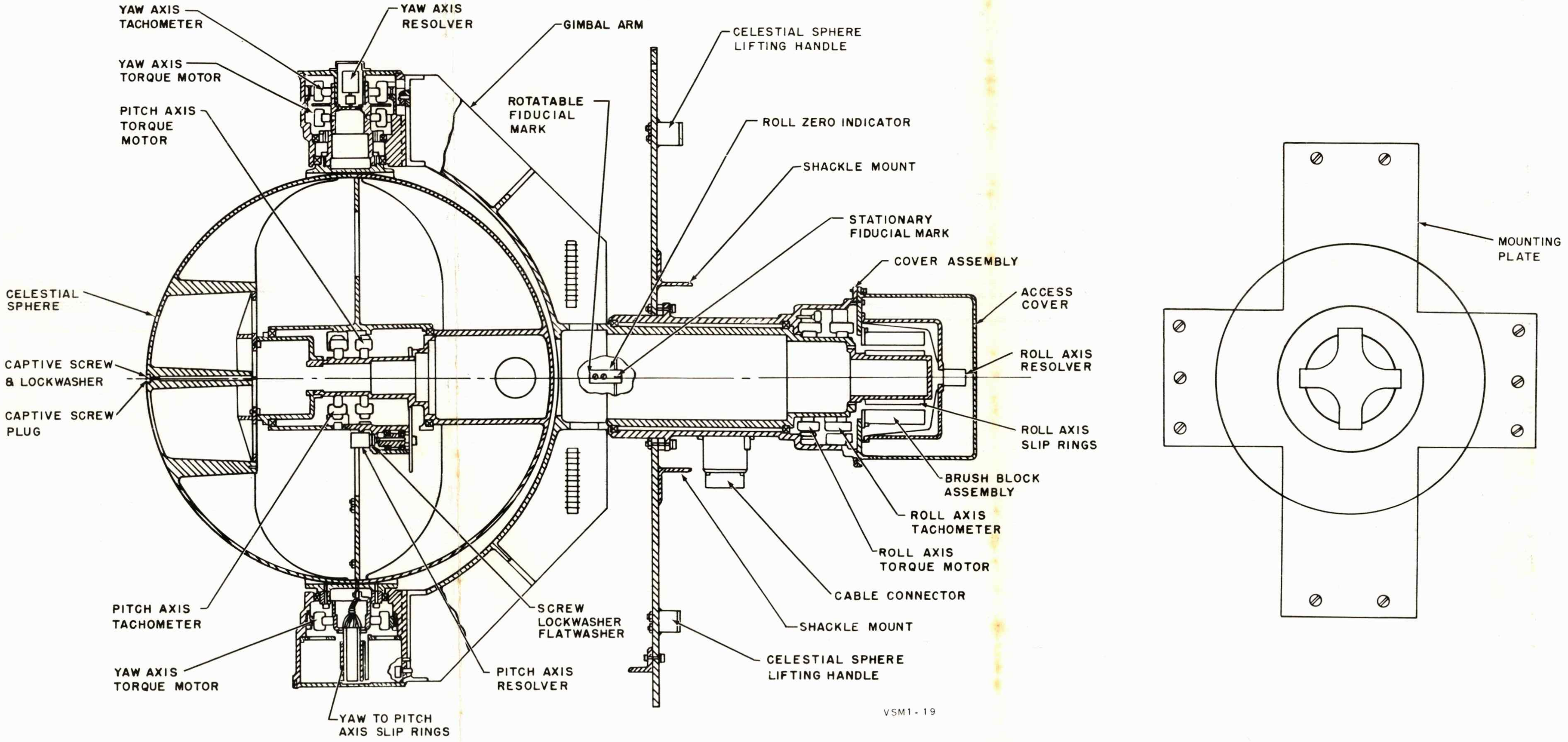


Figure 1-19. Celestial Sphere Components

of illumination described previously, simulates the varying celestial sphere views resulting from pitch, yaw, and roll attitude variations of the command module. The servo systems described are common to the celestial spheres of the rendezvous and docking windows, the landing windows, and the telescope.

1-79. Mechanical Features And Functions. The portion of the true celestial sphere observed at any instant depends upon the attitude of the space capsule axis as described by the orthogonal, transient motions of pitch, yaw and roll. Simulation of the changing view is obtained by mounting the 27-inch diameter celestial sphere in a 3-axis gimbal system. The C/S pitch axis is normal to the simulated plane of the ecliptic. The C/S yaw axis is perpendicular to the pitch axis ecliptic plane, and the roll axis is normal to the plane defined by the pitch and yaw axes.

1-80. Mounting. (See figure 1-19). The entire celestial sphere closed loop servo system is, aside from the elements of the computer, housed and mounted within the celestial sphere assembly. The celestial sphere assembly includes the celestial sphere and the gimballed suspension shown in figure 1-19. It contains the resolver tachometers and torque motors required for achieving correct response to pitch, roll, and yaw signals.

1-81. Electrical Features And Functions. Rotation of the C/S in three degrees of freedom is provided by three closed loop servo systems listed in table 1-8. The AMS computer applies program-derived command signals, in the form of resolver transmitter signals, to the input terminals of the receiver. From this resolver receiver, data elements are continuously driven in response to the computer commands to provide the orthogonal celestial sphere rotations required for the simulation of the programmed mission.

Table 1-8. C/S Servo Systems

Nomenclature	Function
C/S Yaw Axis Servo System	Rotates the celestial sphere about the yaw axis.
C/S Pitch Axis Servo System	Rotates the celestial sphere about the pitch axis.
C/S Roll Axis Servo System	Rotates the celestial sphere about the roll axis.

1-82. Pitch Axis Control Loop. Rotation of the celestial sphere about the pitch axis is provided by a closed loop system (refer to Section VIII for system schematic). Four-wire resolver data generated by the computer, is coupled to the resolver-receiver at the pitch axis of the celestial sphere. This 400-cycle error signal is transmitted through a pitch gain adjust control to the 400-cps preamplifier and demodulator. The amplified and demodulated output signal from this unit is a d-c voltage whose amplitude and polarity is proportional to the amplitude and phase of the a-c error signal. This d-c signal is then applies to the d-c preamplifier via a passive stabilization network which serves to prevent oscillations of the servo loop.

1-83. The output from the d-c preamplifier is applied to the d-c power amplifier AR4. This unit is capable of delivering up to 100 watts of power to the pitch axis torque motor located within the celestial sphere.

1-84. The d-c tachometer, located at the pitch axis, provides an additional means for servo stabilization. This d-c signal, proportional to velocity, is fed through a gain control and diode network to the input of the d-c preamplifier AR3, where it is mixed with the d-c error signal. The series diode limits the introduction of the tachometer signal to time intervals wherein a predetermined velocity has been attained. As a result, the velocity lag, over the specified velocity range of 0-40 degrees per second, is reduced to a minimum. However, the high load inertia makes it desirable to provide tachometer damping whenever a large discrepancy exists between the command data and the actual position of the pitch axis. When this condition occurs (i.e., at initial "turn-on"), the maximum slewing velocity is limited by the tachometer signal, thereby reducing the amplitude and number of overshoots which would otherwise occur during the servo approach to the required null.

1-85. The system is phased so that the error signal causes the pitch axis torque motor to reposition the output shaft until this error signal is minimized. Within the accuracy limitations of the data elements and servo characteristics, the output shaft should then correspond with the position dictated by the computer input signals.

1-86. Yaw Axis Control Loop. Rotation of the C/S about the yaw axis is provided by closed loop system (refer to Section VIII). The yaw axis control loop is identical to that of the pitch axis loop except that two 100-watt torque motors, mechanically and electrically connected in parallel, are used.

1-87. Roll Axis Control Loop. Rotation of the C/S about the roll axis is also provided by a closed loop system (refer to schematic diagram in Section VIII). The roll axis control loop differs somewhat from that of the previously considered control loops. The high inertia (the roll axis carries both the pitch and yaw axes) requires the use of a 300-watt torque motor utilizing a heavy duty power amplifier. In addition to power amplification, the power amplifier also incorporates d-c preamplification thereby eliminating the need for the d-c

preamplifier utilized in the pitch and yaw loops. The command data is applied to the resolver receiver which is coupled to the roll axis is the same manner utilized in the pitch and yaw loops. The error signal is amplified and demodulated in the amplifier demodulator. A potentiometer at the input of this unit serves as a system gain control.

1-88. The d-c output signal is fed into a passive lead-lag network for aiding the servo stabilization. The output from this network is then fed to the power amplifier. Output from this unit is then applied to the torque motor, and the resulting torque causes the roll axis to rotate until the error voltage is reduced to a minimum.

1-89. Tachometer stabilization is utilized in a different manner for this control loop. The high load inertia dictates that a high level tachometer signal be applied in order to insure adequate damping. This is especially necessary during initial synchronization of output shaft to input command. Once the roll axis is positioned in accordance with the input data, and if the command motions do not exceed the specified maximum velocity and acceleration, no tachometer signal is required. (A high tachometer signal cannot be tolerated during normal operation because of its tendency to limit the velocity of the output shaft.) As a result, a relay switching circuit, denoted as the "synchronizing circuit", is incorporated.

1-90. The 400-cycle error signal of the resolver receiver is amplified by transistor A1Q5. The amplified signal is then applied to the base of the relay switching transistor A1Q6. This transistor is cut-off by A1R10. When the a-c signal exceeds a level equivalent to plus or minus 30 minutes of arc (across input resistor A1R16), the positive half of the signal appearing at the base of A1Q6 will cause that transistor to conduct, as a result, relay A1K1 will energize. Capacitor A1C4 holds the relay energized during the negative portion of the a-c signal. The relay remains energized as long as the error signal level exceeds this predetermined level. With A1K1 energized, the tachometer signal proceeds to the power amplifier where it is mixed along with the d-c error signal, thereby providing the desired damping. The effective damping is adjustable by the tachometer gain control located on the chassis.

1-91. Illumination And Occultation. The source of illumination for the celestial display is the projected aerial image of the light from a 500-watt high pressure mercury arc lamp (see figure 1-20). The light source, which is essentially a point source, is relayed to a focal plane near the surface of the first celestial sphere beamsplitter. Within the relay optics is a collimated section where an earth/moon occultation disc is placed. In the rendezvous and docking windows there is a second collimated light section where a LEM occulting disc is located, and an additional intermediate focal plane.

1-92. The relay optics are designed so that the plane of the occulting disc is reimaged on the celestial sphere to provide a sharp image (shadow) of the disc,

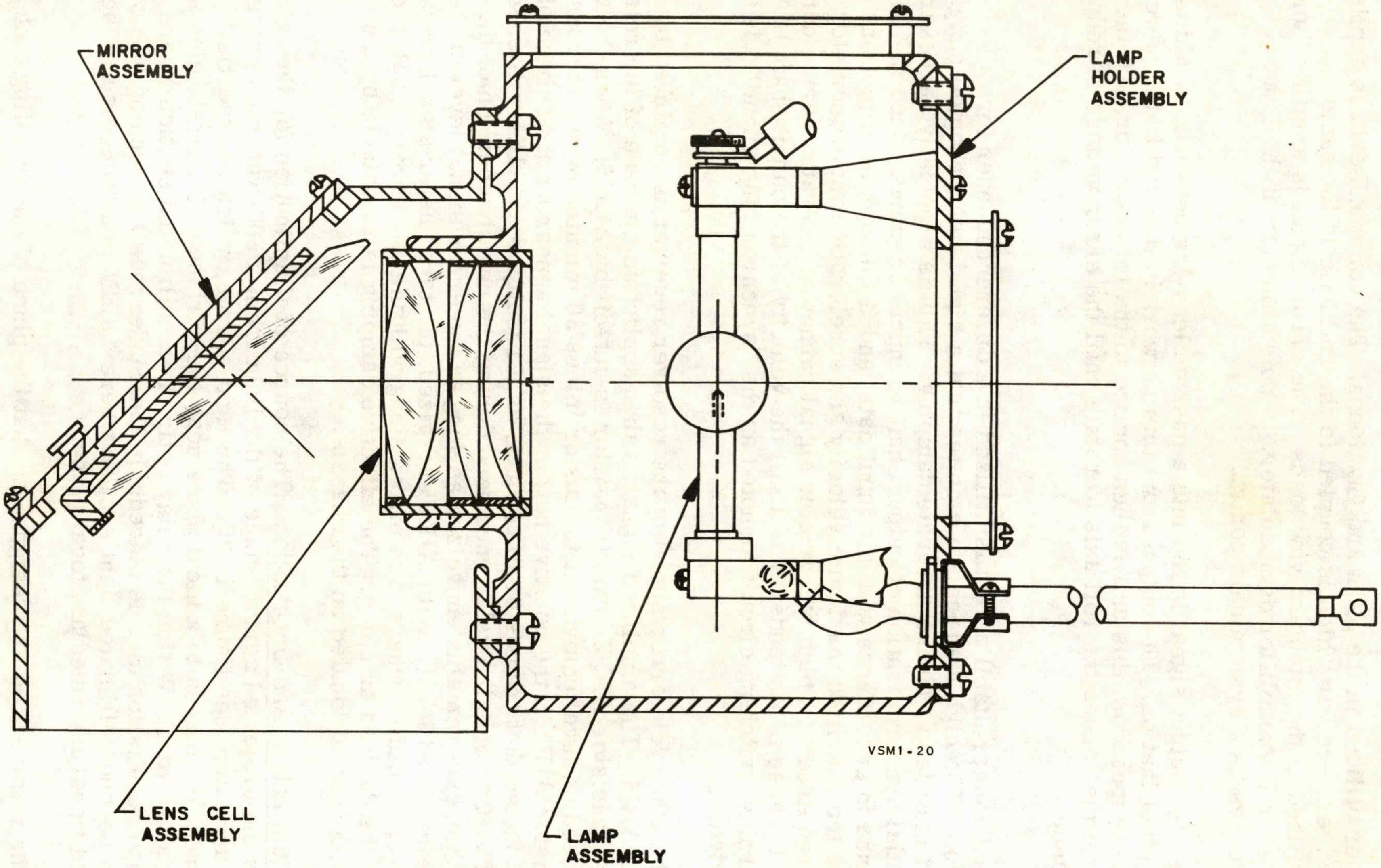


Figure 1-20. Celestial Sphere Illumination Assembly

even when it is off the viewing axis. The necessary angular mapping distortion required to project a circle onto a sphere from an off-axis position is also incorporated in the relay optics.

1-93. Illumination. Illumination of the C/S is provided by a high intensity Osram mercury lamp (see figure 1-20). Light from the lamp completely collimated by a lens cell assembly located directly in front of the light source. The collimated light from the cell assembly is reflected by a mirror through the earth/moon occultation assembly. Light which is allowed to pass through this assembly then travels via a relay lens system to a second occultation assembly. This assembly, provided for target vehicle occultation (not used on the landing windows), blanks out a segment of the light ray. The remaining portion of the light is then relayed through an optical path to the surface of the celestial sphere.

1-94. The lamp itself is a super pressure mercury lamp which combines high luminous efficency with very high brightness and arc stability. In order to obtain brightness and excellent luminous efficiency, the lamp operates with a vapor pressure of up to 30 atmospheres. Therefore, the quartz body of the lamps is subjected to heavy mechanical stresses.

1-95. The lamp is dosed with Mercury and an inert gas. During the warming-up period lasting five to ten minutes the mercury evaporates. At this time mercury vapor pressure and operating voltage rise up to their rated values. Lamp life is impaired by excessive warm-up period, therefore, the ballasting gear is designed to provide a starting current higher than the operating current of the warmed-up lamp. The lamp is considered "warmed-up" when the mercury is evaporated. It is very difficult to measure the bulb temperature. To check for complete evaporation of the mercury filling, increase the operating current to a small extent and observe the operating voltage. A noticeable rise in operating voltage indicates that the warming-up- period is incomplete.

WARNING

> Special protective goggles (Bausch and Lomb Ray Ban type Z 301E) must be worn when working around or with the illumination assembly. The lamp contains a high internal pressure, and the illumination contains an ultraviolet component which can cause blindness.
> Hands, arms, and other exposed skin areas must not be introduced into the light path as serious skin burns will result.

1-96. The life of the lamp can be impaired for many reasons which include: a crack in the quartz, an increased separation of the electrode, electrode wear, insufficient internal pressure, and electrode material spattered onto the quartz walls. It is also affected by the number of times the lamp is started. A lamp will have a longer life with continuous operation than with frequent starts and stops. For average rated lamp life, the minimum burning time should be

two hours per start. A trouble analysis of the illumination assembly is included in Section III.

1-97. Three major components are used in the illumination assembly. Table 1-9 contains the nomenclature and the function of each of these components.

1-98. Occultation. Two occultation assemblies are provided for each of the rendezvous and docking windows while one is provided for each landing window and the telescope. The principles used in each assembly are the same, therefore, only one is discussed. (See figure 1-21.)

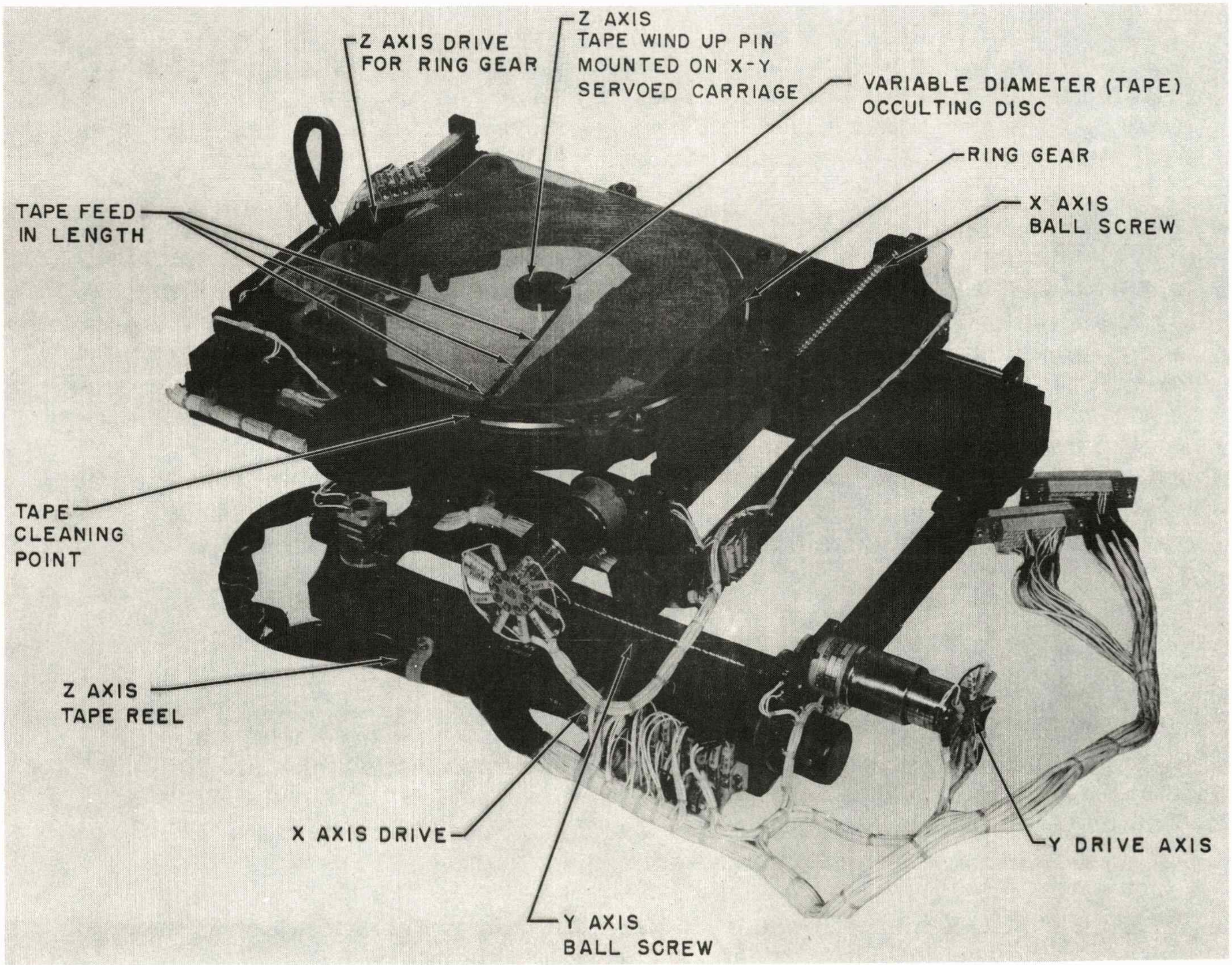


Figure 1-21. Occultation Assembly

Table 1-9. C/S Illumination Assembly Major Components

Nomenclature	Function
Igniter	Provides starting voltage for the mercury vapor lamp.
Lamp Assembly	Furnishes illumination for the window occultation and celestial sphere.
Lamp Holder Assembly	Retainer for the mercury vapor lamp.

1-99. Whenever an object moves into the line of sight between the spacecraft and the stars, the normal scene being viewed would be the object with a background of stars. With the optical system where two or three scenes are superimposed, a method must be employed to mask out various portions of the starfield scene to prevent the stars from shining through the earth, moon, or target vehicle. This is called occulting. If the object being viewed appears to move about, the occulted portion of the starfield must also change. The following paragraphs explain in detail how this is accomplished.

1-100. An occultation mask consists of a flat spool of mylar tape, which is wound onto a bobbin (See figure 1-21). The bobbin is located in the path of collimated light in the starfield illumination optics, with its axis parallel to the optical axis. The bobbin can either "take on" tape to simulate an increase in diameter of the earth or moon or "let off" tape to simulate a decrease in the diameter. The amount of mylar tape that has been wound on the reel of the earth/moon occultation unit represents the circular cross section of either the earth or the moon as it would appear when viewed from the command module.

1-101. The occultation system has associated with it three servo systems, referred to as the X-axis, Y-axis, and Z-axis servos. The X-axis servo controls the linear displacement of the occultation mask normal to the optical axis and in a vertical direction referenced to the window horizontal and vertical. The Y-axis servo is similar to that of the X-axis except its motion is in the horizontal direction. The Z-axis servo is an angular drive whose operation is the winding up of the mylar tape, thus changing the diameter of the disc and hence the diameter of the shadowed area of the celestial sphere.

1-102. The occulting mechanism of the LEM and of the Earth/Moon are essentially identical. The only area of difference is in the limiting sizes of the subtended area, being 6 degrees to 87 degrees for the target vehicle occultation and 6 degrees to 168 degrees for earth/moon occultation.

1-103. The difference in diameter of earth as viewed from different windows and from the scanning telescope of command module is not noticeable. Therefore, a single signal is used to drive the five earth occultation masks, although each servo has its own signal driver.

1-104. The X and Y axis servo systems each drive an associated ball screw to a computer specified position. The computer signals cause the two servo motors to respond, thus driving the X-Y axis carriage in the X-Y plane. The servos thus function to position the tape windup pin, and therefore the tape occultation disc, at any computer directed point within or external to the collimated illumination. The Z axis servo system drives an associated ring gear train which winds or unwinds the mylar tape from the windup pin, thus increasing or decreasing the diameter of the occulting disc as previously described.

1-105. The limit of travel of each of the three servo systems used in the occultation assembly is provided by a two pole double throw relay. Each relay is connected in series with a limit switch which defines the limits of travel. The relays each include one set of normally closed contacts in series with a 28-volt d-c power supply and an indicator lamp. When a servo reaches a limit, the contacts open and the light goes out. The other set of contacts introduces a resistor into the 28-volt d-c power to the servo amplifiers, which in turn, reduces the power to the servo motor. Table 1-10 lists the major components of the occultation servo systems.

Table 1-10. Occultation Servo Systems

Nomenclature	Function
X axis servo system	Controls X direction movement of the X Y servo carriage in the XY plane.
Y axis servo system	Controls Y direction movement of the X Y servo carriage in the XY plane.
Z axis servo system	Controls the diameter of the occultation mask.
Tape winding reel	Winds up the tape into a circular disc.
Mylar tape	Provides the necessary obstruction in the collimated light path.

1-106. MISSION EFFECTS PROJECTOR. The purpose of the five mission effects projectors (MEP) is to provide earth scenes for the telescope/sextant display and earth scenes and solar simulation for the four window displays. The MEP's are mounted on the window displays and the telescope/sextant display so the screen assemblies become an integral part of and major input to the optical paths.

1-107. MEP Major Components. Table 1-11 lists the major components of the MEP in tabular format.

Table 1-11. MEP Major Components

Nomenclature	Common Name	Specific Function
Arc Lamp-Mission Film Lamp Assembly	Lamp	Illuminate mission film
Condenser Subassembly-Mission Film Lamp Assembly	Condenser	Directs illum. uniformly through mission film
Arc Lamp-Transboundary Lamp Assembly	Lamp	Illumination transboundary film
Condenser Subassembly-Transboundary Illumination Assembly	Condenser	Directs illum. uniformly through trans. film
Arc Lamp-Solar Image Assembly	Lamp	Source for solar image
Condenser Subassembly-Solar Image Assembly	Condenser	Directs arc image through aperture of solar system
Cassettes	Cassettes	Drive film and form object plane
Ring Mirror-Extended Off-Course Assembly	Mirror	Provides ext. off course capability
Terminator & Terminator Rotar Assembly	Terminator	Controls day-night terminator
Collimator Lens-Attitude Assembly	Lens	Controls light from collimator to veri-focal

Table 1-11. MEP Major Components (Cont)

Nomenclature	Common Name	Specific Function
Projection Lens-Earth Blanking Assembly	Shutter lens	Projects or blanks off earth scene on projection screen
Projection Screen	Screen	Forms real image of earth scene.
Transboundary Condenser Relay Mirrors-Transboundary Illumination Assembly	Mirrors & lens	Illuminate transboundary film relay image through projection lens to screen
Transboundary Illumination Assembly	Transboundary projector	Projects film transboundary scene to screen
Horizon Mask Assembly	Mask	Forms image of horizon on screen for transboundary image
Transboundary Limb Variation Assembly	Limb	Varies size of earths limb 104° to 152.5°
Relay Lens No. 1 Assembly Collimator	Relay lens	Relays image from altitude vari-focal to the day-night term. plane

1-108. Hardware Description. The MEP is a completely enclosed unit that resembles a large rectangular box with a smaller rectangular box mounted at the lower rear and a tabular projection with a convex surface mounted on the lower front of the larger box. The smaller box at the rear is the transboundary lamp assembly and the tabular projection at the front is the screen assembly.

1-109. Overall Dimensions And Weight. The overall dimensions of the MEP including the trans-boundary lamp assembly and the screen assembly are:

a. Length - 104 inches

b. Width - 33 inches

c. Height - 70-1/2 inches

The MEP weighs approximately 650 pounds.

1-110. Electrical Power Requirements. Table 1-12 lists the electrical power requirements for the MEP.

Table 1-12. MEP Power Requirements in Watts

		* 28 V DC		115 V, 400 CY+5% 1Ø		208/115V 60 CY3Ø	
Item	**Name**	**Unit**	**System**	**Unit**	**System**	**Unit**	**System**
1.	Earth Film Illuminator Varifocal Drive	48	240	48	240	—	—
2.	Earth View Angenieux Zoom Servo	24	120	24	120	—	—
3.	Iris Servo	12	60	12	60	—	—
4.	Solid Cloud Cover Varifocal Servo	24	120	24	120	—	—
5.	Mirror Translation Drive for Off-Course	17	85	17	85	—	—
6.	Day-Night Term	17	85	17	85	—	—
7.	Pitch Scanner Servo	17	85	17	85	—	—
8.	Yaw Scanner Servo	17	85	17	85	—	—
9.	Derotator	17	85	17	85	—	—
10.	Earth Film Off-Course	50	250	40	200	—	—
11.	Earth Film Orbital Drive	1000	5000	1000	5000	—	—
12.	Turret Drive	60	300	50	250	—	—
13.	Illumination Quick Dissolve	84	420	—	—	—	—

Table 1-12. MEP Power Requirements in Watts (Cont)

		* 28 V DC		115 V, 400 CY+5% 1Ø		208/115V 60 CY3Ø	
Item	Name	Unit	System	Unit	System	Unit	System
14.	Blanking Shutter	42	210	—	—	—	—
15.	Sunrise - Sunset	56	280	—	—	—	—
16.	Relays	15	75	—	—	—	—
17.	Pneumatic Drive	84	420	—	—	—	—
18.	Lamps	—	—	—	—	10,000	50,000

1-111. MEP Servo Drive Generation. Figure 1-22 shows the relationship of the MEP to the IIS and the generation of the MEP input control signals. The MEP math model in the computer complex provides an input to the DCE associated with the MEP. The DCE translates the computer output to analog drive voltages usable by the MEP electronics. A patch panel routes these drive voltages to the appropriate MEP electronics unit. The output of the electronics unit drives a servo within the MEP to provide the proper earth display at the MEP output screen relative to position, prespective, and attitude of the SCM in orbit. The scene projected onto the MEP screen is viewed via the IIS by the astronaut. Table 1-13 lists all the servos in the MEP with their functions.

1-112. MEP Power Supplies. A total of 5 MEP power supply cabinets (units 88, 89, 90, 91, and 92) are used with the AMS. Four of the five cabinets (one for each window MEP) contain three power supplies. One power supply is used to supply power to the mission film are lamp, one for the transboundary (clouds) are lamp, and one to the solar arc lamp. The exception is unit 88, the telescope MEP power supply, which has no solar arc lamp as the effect of sunshafting is not incorporated.

1-113. Upon command from the computer, a signal is applied to the mission film arc lamp power supply which turns on the d-c power to the lamp. After a time delay of 10 seconds, the ignite signal is applied which starts the lamp. One minute later a similar pair of signals is applied to the second mission film arc lamp power supply. This is continued until all mission film arc lamps are turned on. The same procedure is used to turn on the transboundary film arc lamps and finally, the solar arc lamps. All lamps must be on at least 15 minutes prior to entering the 100 mile orbit. The complete sequencing is programmed in the computer; however, during manual operation, the same procedure should be followed.

1-114. All MEP arc lamps are interlocked with the air compressor to prevent the lamps from turning on if the air compressor is not in operation. The interlock is designed to turn off the lamps in case the air compressor fails or if it does not deliver the proper air pressure.

1-115. Mission film power supply. The 3000 watt power supply provides regulated current to power a Hanovia, or equivalent, Type 929B arc lamp used for illumination of the mission film. The power supply and associated control panel are housed in a heavy duty, 24 inch equipment rack. Remote and manual power operation and visual indicators are provided as features of the unit. The unit consists of a control panel, relay control module, power supply, and a transistorized servo control amplifier.

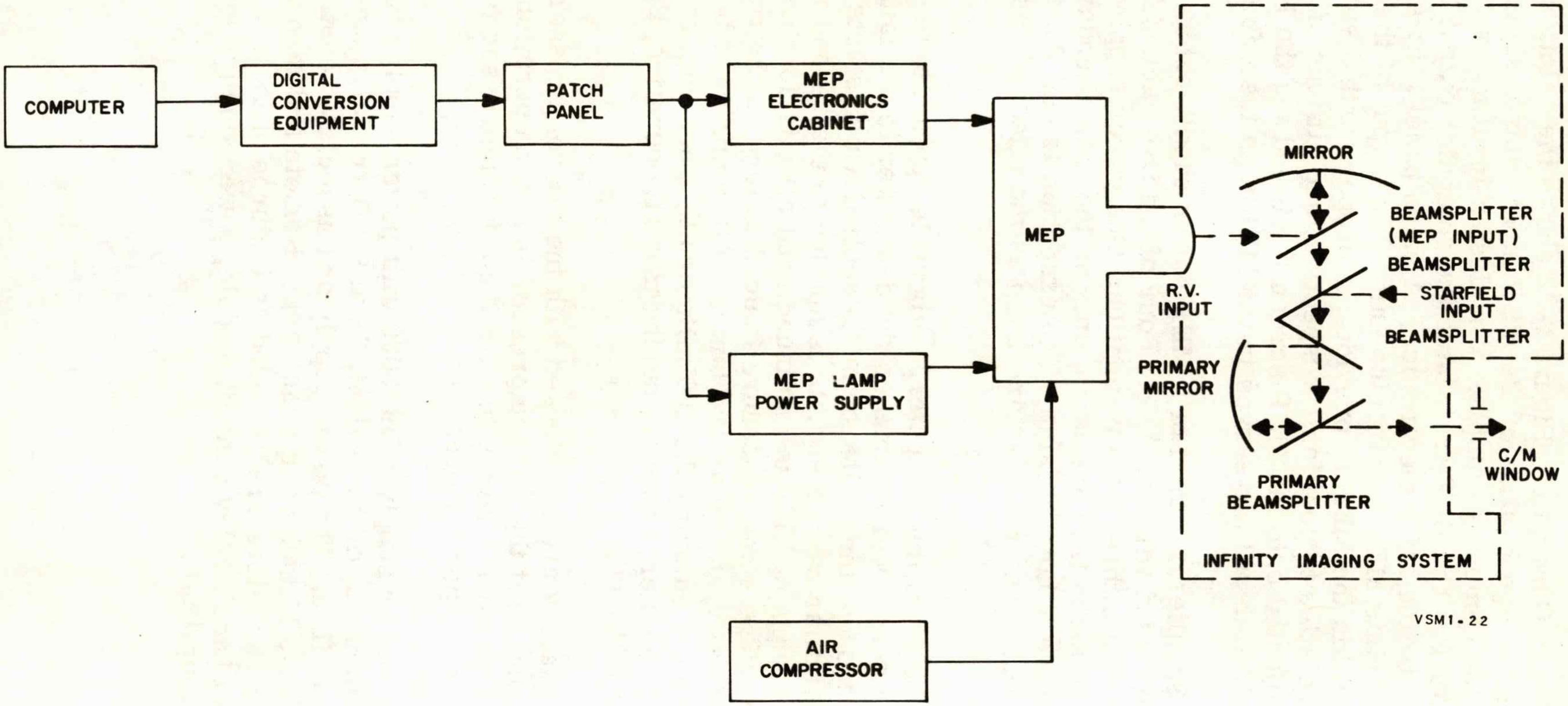


Figure 1-22. MEP/IIS Interface, Block Diagram

Table 1-13. Mission Effects Projector Servo Functions

Name	Type	Function
Off Course		
Off-Course I	Two Speed D-C Input	Drives cassettes in turret No. I in the off-course (horizontal) plane. Also used to drive the cassettes into position for reindexing.
Off-Course II	Two Speed D-C Input	Drives cassettes in turret No. II in the off-course (horizontal) plane. Also used to drive the cassettes into position for reindexing.
Extended Off-Course	Two Speed D-C Input	Drives extended off-course ring mirror when off-course exceeds 400 nautical miles.
Solar Image		
Pitch	D-C Input	Drives the solar image mirror in the pitch plane.
Yaw	D-C Input	Drives the solar image mirror in the yaw plane.
Focus	D-C Input	Drives the solar image varifocal lens to keep solar image in focus during travel over the convex projection screen.
Attitude		
Pitch	Resolver Input	Drives the attitude mirror in the pitch plane.
Yaw	Resolver Input	Drives the attitude mirror in the yaw plane.
Roll	Resolver Input	Drives a dove prism about the vertical areas. This causes the image to rotate (roll).
Special Effects		
Terminator Rotator	D-C Input	Rotates the Day-Night Terminator to compensate for the different orbital paths taken by the SCM so that the day-night line will be in its correct perspective.

Table 1-13. Mission Effects Projector Servo Functions (Cont)

Name	Type	Function
Orbital View		
Near Earth	Resolver Input	Drives the earth orbit film at turret I position A.
Mid-Moon	Resolver Input	Drives the moon orbit film at turret II position C.
Trans Earth/Lunar View/Transboundary View		
Trans-Earth	Resolver Input	Drives the Trans-Earth film strip at turret II position A.
Trans-Lunar	Resolver Input	Drives the Trans-Lunar film strip at turret I position C.
Transboundary	Resolver Input	Drives Transboundary film at the transboundary cassette.
Vertical Range		
Range I	D-C Input	Drives the turret I zoom lens to simulate changes in SCM altitude.
Range II	D-C Input	Drives the turret II zoom lens to simulate changes in SCM altitude.
Iris	D-C Input	Drives the iris in the turret I leg to simulate blue sky changes to black during boost off scene.
Earth Moon Illumination		
Illumination I	D-C Input	Drives a varifocal lens in turret I to compensate for light density changes when SCM changes altitude.
Illumination II	D-C Input	Drives a varifocal lens in turret II to compensate for light density changes when SCM changes altitude.

Table 1-13. Mission Effects Projector Servo Functions (Cont)

Name	Type	Function
Terminator	D-C Input	Drives the day-night terminator to simulated changes from day to night.
Earth Moon View Selection/Transboundary Illumination		
Turret Drive I	D-C Input	Operates on four standard inputs to position turret I to one of four cassette positions.
Turret Drive II	D-C Input	Operates on four standard inputs to position turret II to one of four cassette positions.
Transboundary illumination	D-C Input	Drives varifocal lens to vary the illumination of cloud cover as SCM altitude varies.
Transboundary Effects		
Vertical Range	D-C Input	Drives zoom lens in transboundary leg to increase or decrease cloud definition in proportion to altitude.
Limb Variation	D-C Input	Drives varifocal lens in transboundary leg to increase or decrease transboundary effects in size, proportional or altitude.
Cassette Rotator	D-C Input	Rotates transboundary cassette to simulate shifts in SCM position. Keeps transboundary effects in true perspective at all SCM attitudes.

1-116. The 3 kw mission film power supply provides up to 3000 watts of regulated power. It incorporates features of relay control, which eliminates the possibility of human error, and a momentary step-up voltage to insure instant lamp ignition. The instant lamp ignition feature eliminates the need for successive ignition tries and assures extended life of the arc lamp. Weak lamps ignite readily under the momentary step-up voltage condition. Components with a "high probability of failure" rating are designed as plug-in modules to provide ease of maintenance and minimize down-time when in operation.

1-117. Five mission film power supplies are used with each AMS and are housed along with other power supplies in units 88, 89, 90, 91, and 92. Each of these units is located in close proximity to its associated mission effects projector. The mission film power supplies are each rack mounted with easily accessible test points and power connections. The major electrical characteristics are as follows:

a. Input characteristics:

1. Input voltage: 120/280 plus or minus 10 percent

2. Phase: 3Ø, 4 wire wye

3. Frequency: 60 ± 5 cps

4. Input voltage, DC: 28, 50 volt ampere and 28 volt ground for all Boolean signals.

b. Output characteristics:

1. Current: 20-75 amps

2. Power: 3000 watts

3. Current regulation: less than 2 percent

4. Current ripple: less than 5 percent peak-to-peak

5. Open circuit voltage: 70-110 volts

6. Igniter voltage: 120 VAC plus or minus 10 percent (available instantly upon ignite command)

7. Line drop: operates with line drop of 15 percent for 0.25 second

8. Audio noise: 65 db above 0.002 microbar

9. Conducted RFI: less than 26.2 mv peak-to-peak from line-to-line input

10. Starter keying signal: 120 VAC

1-118. Solar power supply. The 400 watt power supply provides regulated current to power a Hanovia, or equivalent, Type 929B arc lamp used for illumination of the solar effects. The power supply and associated control panel are housed in a heavy duty, 24 inch equipment rack. Remote and manual power operation and visual indicators are provided as features of the unit. The unit consists of a control panel, relay control module, power supply and a transistorized servo control amplifier.

1-119. The 400 watt solar power supply provides up to 400 watts of regulated power. It incorporates features of relay control, which eliminates the possibility of human error, and momentary step-up voltage to insure instant lamp ignition. The instant lamp ignition feature eliminates the need for successive ignition tries and assures extended life of the arc lamp. Weak lamps ignite readily under the momentary step-up voltage condition. Components with a "high probability of failure" rating are designed as plug-in modules to provide ease of maintenance and minimize down-time when in operation.

1-120. Four solar power supplies are used with each AMS and are housed along with other power supplies in units 89, 90, 91, and 92. Each of these units is located in close proximity to its associated mission effects projector. The mission film power supplies are rack mounted with easily accessible test points and power connections. The major electrical characteristics are as follows:

a. Input characteristics:

1. Input voltage: 120/280 plus or minus 10 percent

2. Phase: 30, 4 wire wye

3. Frequency: 60 ±5 cps

4. Input voltage, DC: 28, 50 volt ampere and 28 volt ground for all Boolean signals

b. Output characteristics:

1. Current: 7-25 amps

2. Power: 150-400 watts continuous duty

3. Current regulation: less than 1 percent

4. Current ripple: less than 3 percent peak-to-peak

5. Open circuit voltage: 70-110 volts

6. Igniter voltage: 120 VAC plus or minus 10 percent available instantly upon ignite command

7. Line drop: operates with line drop of 15 percent for 0.25 seconds

8. Audio noise: 60db above 0.002 microbars

9. Conducted RFI: less than 26.2 mv peak-to-peak from line-to-line input

10. Starter keying signal: 120 VAC

1-121. Transboundary Power Supply. The 3000 watt power supply provides regulated current to power a Hanovia, or equivalent, Type 929B arc lamp used for illumination of the transboundary effects. The power supply and associated control panel are housed in a heavy duty, 24 inch equipment rack. Remote and manual power operation and visual indicators are provided as features of the unit. The unit consists of a control panel, relay control module, power supply and a transistorized servo control amplifier.

1-122. The 3 kw transboundary power supply provides up to 3000 watts of regulated power. It incorporates features of relay control, which eliminates the possibility of human error, and momentary step-up voltage to insure instant lamp ignition. The instant lamp ignition feature eliminates the need for successive ignition tries and assures extended life of the arc lamp. Weak lamps ignite readily under the momentary step-up voltage condition. Components with a "high probability of failure" rating are designed as plug-in modules to provide ease of maintenance and minimize down-time when in operation.

1-123. Five transboundary power supplies are used with each AMS and are housed along with other power supplies in units 88, 89, 90, 91, and 92. Each of these units is located in close proximity to its associated mission effects projector. The transboundary power supplies are each rack mounted with easily accessible test points and power connections. The major electrical characteristics are as follows:

a. Input characteristics:

1. Input voltage: 120/280 plus or minus 10 percent

2. Phase: 3Ø, 4 wire wye

3. Frequency: 60 ±5 cps

4. Input voltage, DC: 28, 50 volt ampere and 28 volt ground for all Boolean signals

b. Output characteristics:

1. Current: 20-75 amps

2. Power: 3000 watts continuous duty

3. Current regulation: less than 2 percent

4. Current ripple: less than 5 percent peak-to-peak

5. Open circuit voltage: 70-110 volts

6. Igniter voltage: 120 VAC plus or minus 10 percent (available instantly upon ignite command)

7. Line drop: operates with line drop of 15 percent for 0.25 seconds

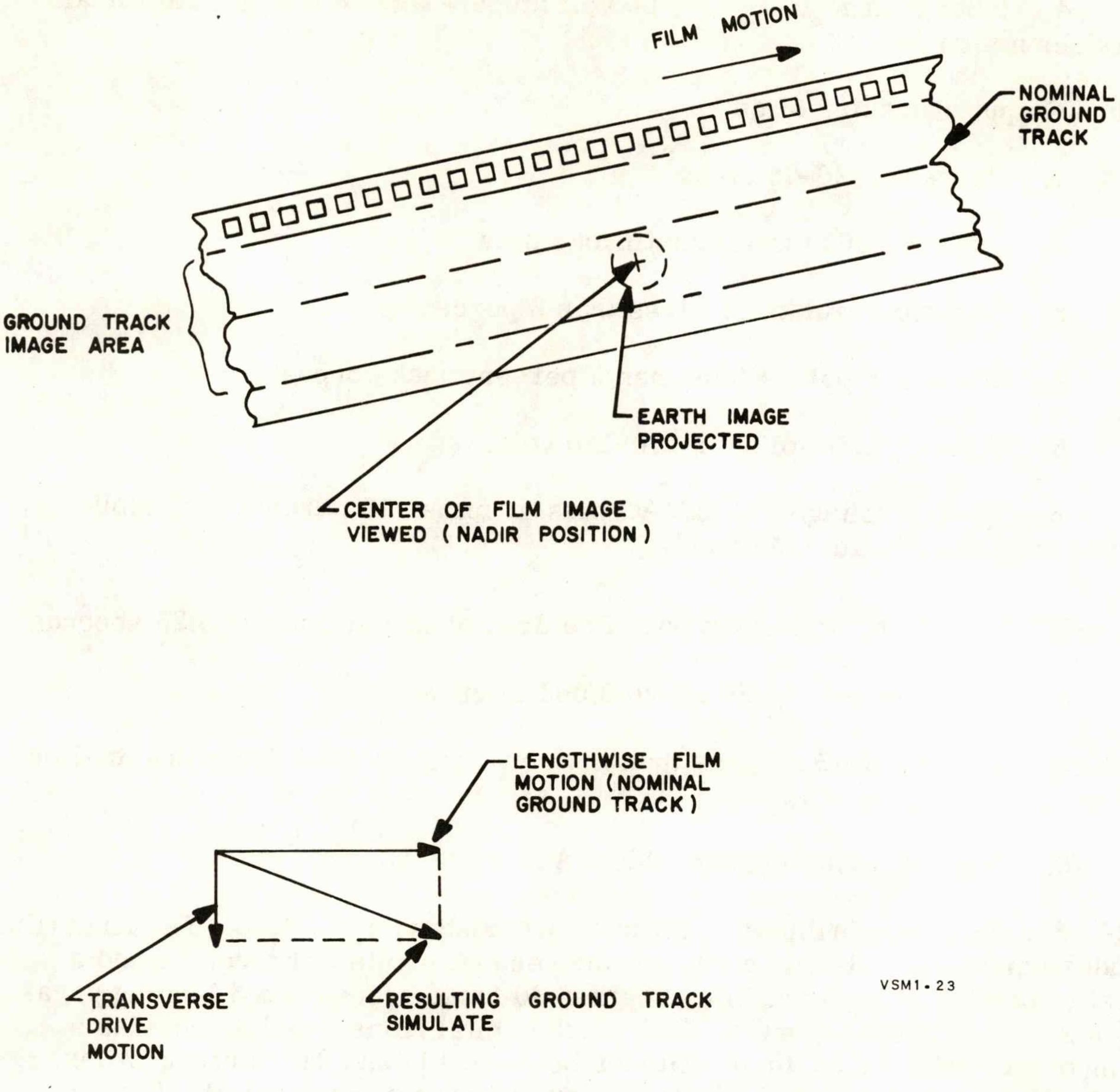
8. Audio noise: 65 db above 0.002 microbars

9. Conducted RFI: less than 26.2 mv peak-to-peak from line-to-line input

10. Starter keying signal: 120 VAC

1-124. FILMS. Three films are initially provided with the AMS. The first film includes earth orbits 1 through 9, and the second, orbits 9 through 16 and a repeat of orbit 1. The third film provides 30 lunar scenes and 3 landing parachutes scenes. The imagery of MEP earth orbital films 1 and 2 provides a continuous view of the earth at altitudes between 100 and 215 nautical miles. That is, films 1 and 2 provide 16 continuous film sections (orbits). The additional orbit indicated on film two is a repeat of Section I on film one. Thus, the first section on film 1 is also used for orbits 17, 33, etc.

1-125. Orbit inclination between 32 and 34.5 degrees is simulated. Altitude changes are simulated by changes in vertical range varifocal lens assemblies in the image optical path. An individual film, in conjunction with the central image generation assembly optics and transboundary assembly optics, provides for an altitude variation of 2.15:1. The altitude range and optical characteristics of the MEP thus determine the required nominal scale factor of the film. The central 90 degree portion of the image shows ground details suitable for identification and orbital navigation as provided by the film use. A sketch of a film section is shown in figure 1-23.



NOTE: FILM MOVES AT A RATE PROPORTIONAL TO SPACECRAFT VELOCITY RELATIVE TO EARTH; MOVEMENT OF SPACECRAFT ACROSS GROUND TRACK SIMULATED BY MOVING FILM UP OR DOWN RELATIVE TO IMAGE PATH.

Figure 1-23. Central Image Film Layout

1-126. The film prints are Ektachrome medium speed, special order color film on a 0.004 inch polyester base. The film width is 5 inches (127 mm) nominal, with 114 mm usable image width. Perforations conform to Eastman positive perforation specification 1870 (D-HO.110X0.073). The resolution of a final film print, made from a master, photographed from a resolution test chart, and using the assigned strip film camera is 30 lines per mm. Film strips each include a test pattern, and zero position indication notch on the Y reference edge of the film. The film prints are a combination of scene sequences or orbits up to a maximum of approximately 90 feet per film section. Spliced film is not to be used if the spliced area will pass through the film gate.

1-127. When the film is viewed in the direction of travel the emulsion is on the facing to the illumination source side of the film, the Y reference edge on the right. The location of the image is referenced to the film Y reference which is toward the fixed shoulder of the film guide rollers. The center of the film ground track of orbital strip images is 63 ±0.003 mm of the Y reference edge.

1-128. The lengthwise (X) scale factor of the prints is within three percent of the specified scale factor and the "Y" scale factor (across the film) is within three percent of the X scale factor. The instantaneous, or cumulative deviation from print to print does not exceed 0.5 mm.

1-129. Films provided for use in the peripheral area film cassette of the MEP have characteristics as specified above. The film is scaled for 100 mm minimum with the film scale factor of 8.77 miles/mm. The image shows continuous cloud area of various white formations on a blue tinted background.

1-130. RENDEZVOUS IMAGE GENERATION.

1-131. The rendezvous system enables simulation of the mission phases up to rendezvousing with a target vehicle. The system provides the required visual clues at the SCM windows two and four. These visual clues are implemented by a model, an associated motion system, a TV pick-up system, and a CRT display system.

1-132. The model complex is composed of a motion system and a lighting system. The motion system consists of a six-degree of freedom unit and a rendezvous-target model. The target is a detail model mounted on a three-gimbal system; the motion of the model represents the three degrees of rotational freedom of the vehicle relative to the SCM. The lighting system is capable of simulating the effect of the light from the sun or reflected light from the earth or moon. This reflected light is simulated by a bank of relatively low intensity lamps.

1-133. The TV camera used for image generation and its optical pickup for the model image are mounted on a servo driven carriage. The carriage rides on a pair of two-inch rails formed from four foot sections of steel tubing. The wheels

on one side of the carriage are V-grooved to maintain carriage alignment with the rails. The wheels on the opposite side are flat to allow it to ride on top of the rail, thus permiting some deviation from perfect rail and wheel alignment without binding or "riding up". The carriage rails are about 7.5 feet long with approximately 87 inches of active travel.

1-134. The image generation portion of the rendezvous system provides two TV displays which, when viewed via the IIS of the SCM windows, presents the target vehicle in the proper attitude, illumination, size, and orientation relative to the field-of-view. The output of the rendezvous system is superimposed on the MEP and starfield display output images in the window IIS.

1-135. MODEL HOUSE. The model house (see figure 1-24), located in close proximity to both the simulated command module and the instructor-operator station, contains a trestle, a twin-vidicon package, a two-gimbal sun system, a three-gimbal model system, and associated equipment used for visually presenting the rendezvous and docking phase of the mission. The prefabricated enclosure consists of 28 major panels and, when assembled, measures 18 feet 4 inches in length by 6 feet in width, and is 7 feet high. Each panel is numbered for ease in assembling, with vertical panels numbered on the top edge, and the roof panels on the edge facing the front of the enclosure. Disassembled, the largest single section is seven feet by four feet. A flat pattern layout of the panels is shown in figure 1-25.

1-136. Two access panels are provided on the enclosure, one at each end. At the base of the enclosure on the left-hand end just below the access panel, conditioned air is fed through dust filters to the interior. The air is discharged through two vents in the roof.

1-137. An adjustable interior partition with a cutout is installed which separates the track-mounted vidicon carriage area from the sun ring, gimbal, and model area of the enclosure. This is installed to prevent any stray light from entering the vidicon tube, and to conceal the sun ring equipment and gimbal system from the vidicon field of view.

1-138. Two sliding access doors are provided on the front of the enclosure, one at each end. The doors, when closed and latched, are seated in a sponge rubber seal to insure the light-tight condition.

1-139. The outside of the model house is an embossed stucco pattern in natural aluminum color. The entire inside of the enclosure is painted a lusterless black to absorb any excess light and reduce reflection. All associated hardware inside is also painted lusterless black.

1-140. Trestle And Vidicon Carriage Assembly. The trestle is used to support the vidicon carriage assembly, model, sun gimbals, and associated hardware (see figure 1-26). The vidicon carriage assembly rides on a pair of evenly spaced 2-inch diameter rails which allow a total travel length of approximately 90 inches.

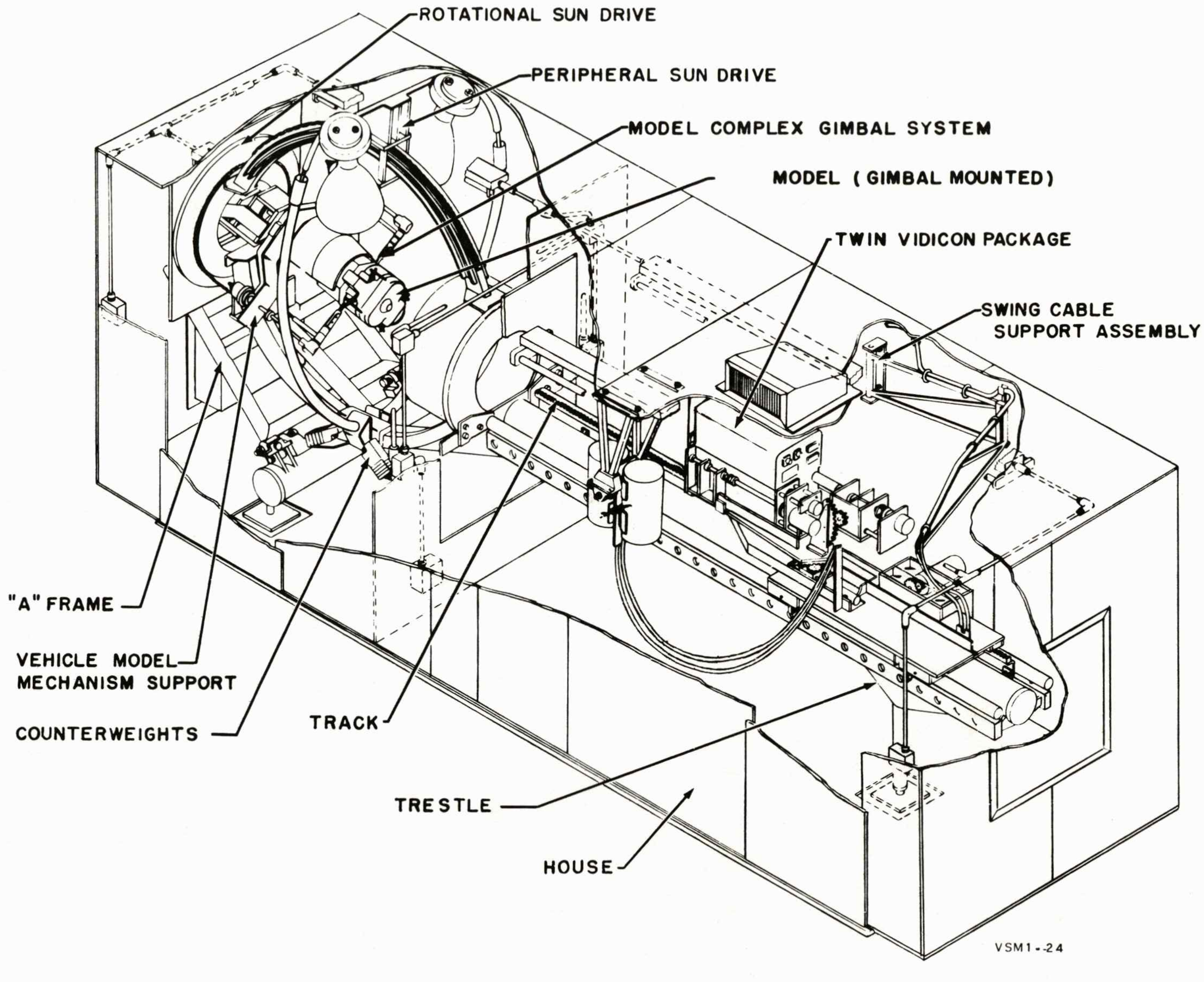
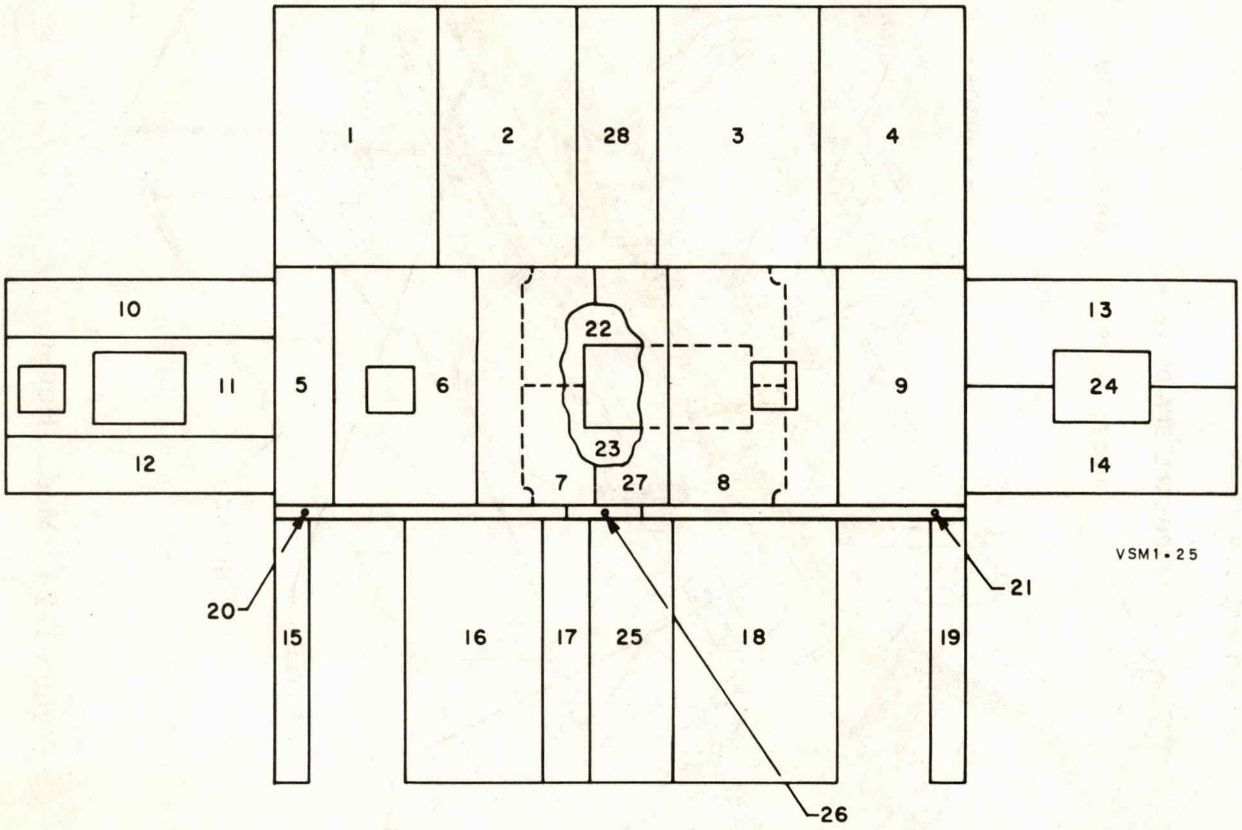


Figure 1-24. Model House



NOTE: LINK PART NO. FOR MODEL HOUSE IS 566737

Figure 1-25. Model House Flat Pattern Layout

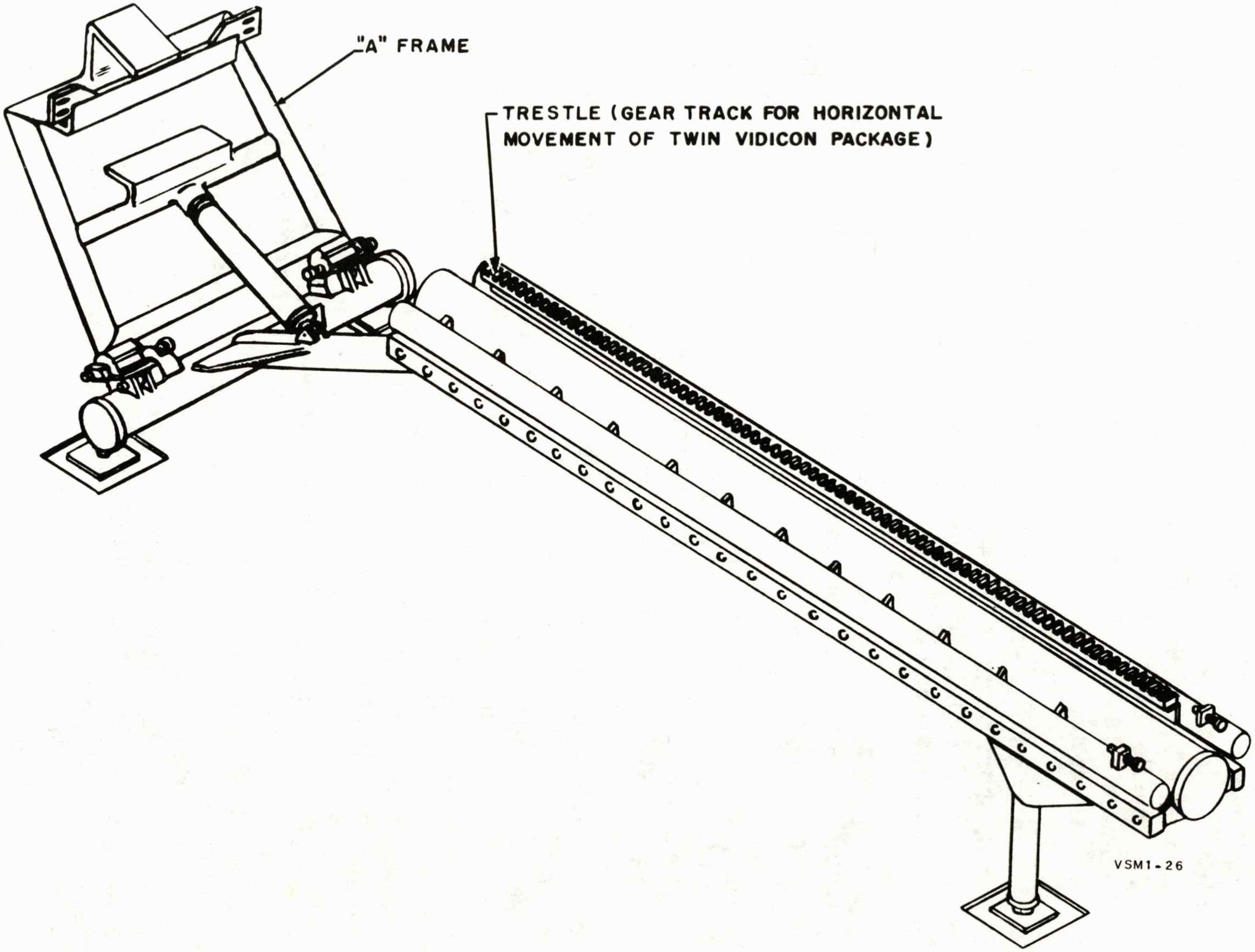


Figure 1-26. Trestle

The rails are formed from four-foot sections of steel tubing. The wheels on one side of the carriage are V-grooved to maintain alignment with the rails. A flat-wheel which rides the top of the rail is installed on the opposite side of the carriage to allow for any thermal expansion without binding. At the maximum distance of travel in either direction, a shock absorbing mechanical stop is installed on the trestle to prevent the vidicon carriage from excessive vibration and jarring. The trestle is rigidly supported at 3 points and has an overall length of approximately 16 feet. The complete assembly is painted a lusterless black to reduce reflection.

1-141. The vidicon carriage assembly includes the vidicons, deflection coils, lens focus servos, short range servo drive, α and β position servos, cable support, and a counterweight. The counterweight is necessary to bring the center of gravity of the assembly into a fully balanced position.

1-142. Target Vehicle Model Complex. The target vehicle model complex (see figure 1-27) includes two gimbal systems; one for the sun and one for the model. Both systems have a common center of rotation. (See figure 1-28.)

1-143. The sun gimbal system consists of two semicircular arms supporting two high-intensity mercury vapor lamps, the sun peripheral servo, associated hardware, and counterweights, A sun rotational servo is installed which allows the gimal to rotate 360 degrees around its hub.

1-144. A chain driven sun lamp carriage (see figure 1-29) is mounted on one arm of the sun gimbal system and is controlled by signals from the sun peripheral servo, a limited range servo system. (See figure 1-30.) This enables the sun lamps to be positioned along the gimbal arm. With the combination of the two movements, the sun lamp assembly can rotate about the model or can move translationally. The beams of light from the sun lamps are over-lapping along the edges and provide a circular light pattern of extremely high intensity at the surface of the model.

1-145. The simulation of the sun by means of two lamps theoretically causes double shadowing. The finite area of the light sources, as opposed to point sources, causes blending of the shadows, thereby removing any shadows cast by the model support arms. This permits placement of the sun at any position between the observation port through which the camera lens views the model and the plane of the model center of gravity (center of model rotation) which is normal to the optical axis. Placement of the sun on the optical axis plane is impractical because of the light reflecting from the camera carriage track into the lens, or the lamps shining directly into the lens in the terminal phases of docking. The sun peripheral servo drive signals are brought in through slip rings mounted around the hub of the sun rotation axis.

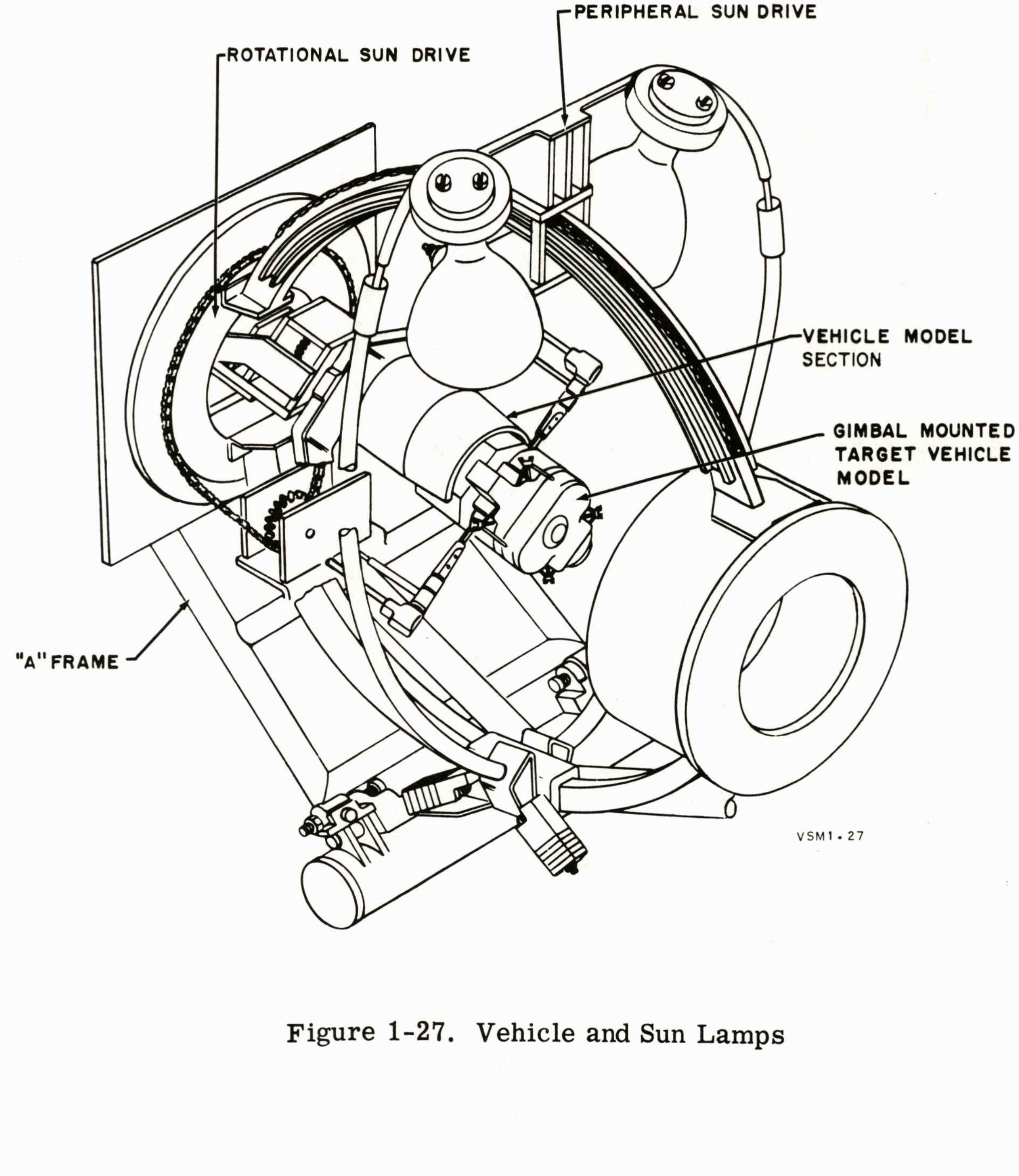


Figure 1-27. Vehicle and Sun Lamps

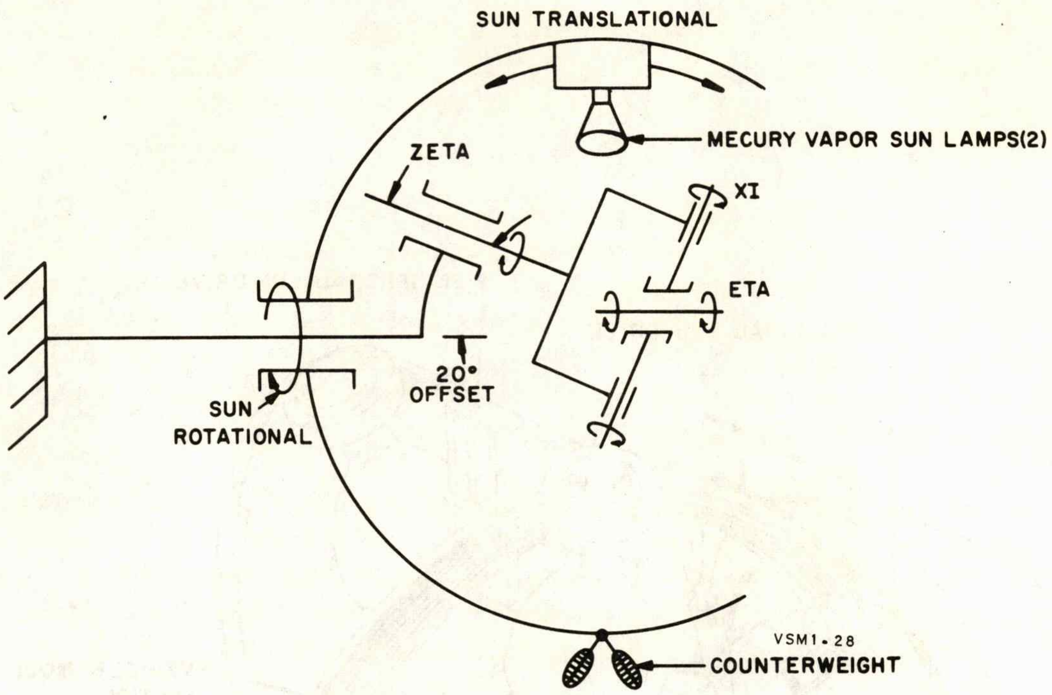


Figure 1-28. Target Vehicle Model Complex Axes

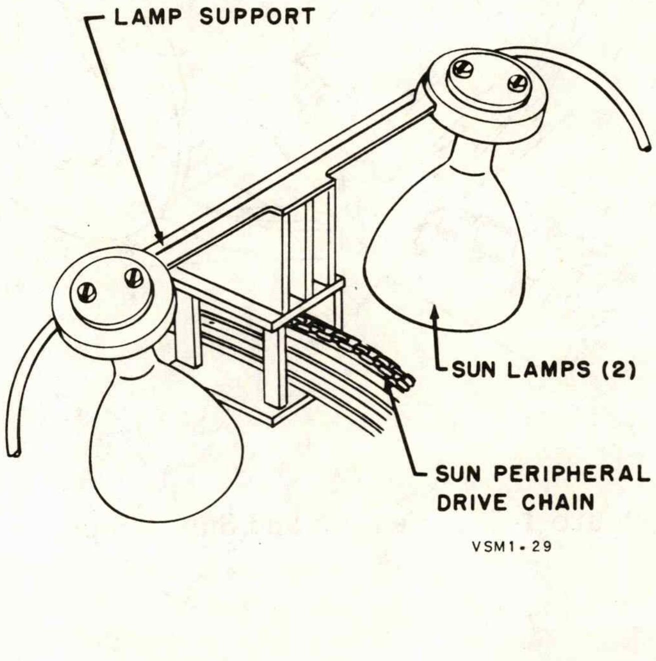


Figure 1-29. Sun Lamps

1-146. The arm on which the sun lamps are mounted is also free to move in a circular path around the line of sight axis. This continuous motion without limit allows full coverage of simulated sun position over a spherical segment about 55 degrees high.

1-147. The target model lighting system simulates the effect of the light from the sun when the target vehicle is not in the conical shadow formed by either the earth or the moon. It also simulates the effect of the reflected light from the earth or moon when the target vehicle is in the conical shadow formed by either the earth or the moon. The reflected light from the earth or the moon is simulated by a bank of lamps of relatively low intensity which flood the model with either moonlight or earthlight.

1-148. Model Simulation and Gimbal System. The model gimbal system is designed to allow rotation of the target model in three degrees of freedom. It is offset 20 degrees relative to the optical axis of the camera and the rails to avoid gimbal lock in the docking position. The three axes are controlled by continuous-rotation position servos labeled **ETA**, **ZETA**, and **XI**. These servos allow the target model to pitch, roll, spin, and tumble in any direction. A block diagram of a typical continuous rotation servo system of this type is shown in figure 1-31. The movement of the target model is controlled by signals from the computer. When a signal is received, the appropriate servo or servos drive to the position specified.

1-149. Vidicon Carriage Assembly. (See figure 1-32.) A twin-vidicon package and its related electronic components is mounted on the movable carriage assembly. Each vidicon views the model from a slightly different angle, and each of the two views is transmitted to its associated window on the simulated command module, the left vidicon transmitting to window number two, and the right vidicon to window four.

1-150. When the astronauts view the target from the command module, a slightly different view is seen, therefore two vidicons are needed to produce the proper effect. As the simulated command module approaches the model, the area being viewed changes proportionately with decreasing distance to a point where almost an entirely different view is seen from the two windows (see figure 1-33). The vidicons are spaced 2.45 inches apart, which is one-twentieth the distance between windows in the operational spacecraft: they are offset from the direct line of sight of the model by two-inches to compensate for the actual offset of the command module windows and the target vehicle during docking procedures. (See figure 1-34.)

1-151. Twin Vidicon Package. The twin-vidicon package has two vidicons (RCA 8480) with electro-static focusing and magnetic deflection coils. It is separated from the deflection electronics and is contained in a shielding housing. Shielding of the vidicon package is provided to avoid interferences with external fields. The inside walls of the focusing mounts are black matt finished to avoid reflections.

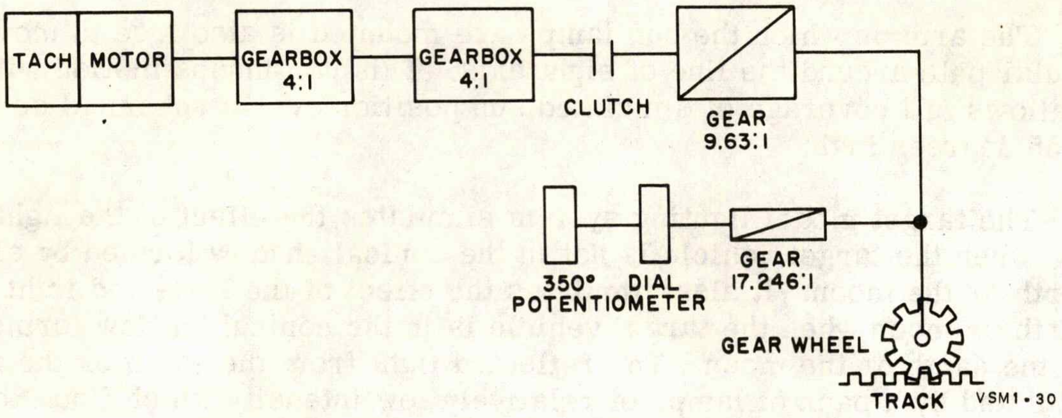


Figure 1-30. Typical Limited Range Servo System (Camera Carriage Servo Drive Shown)

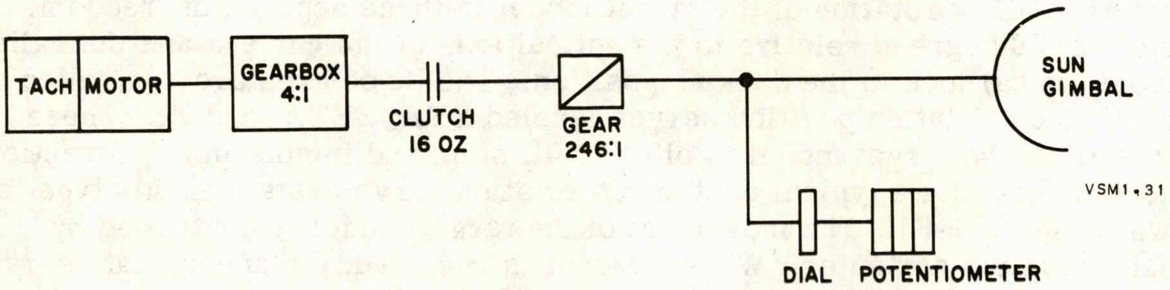


Figure 1-31. Typical Continuous Rotation Servo System (Sun Rotational Servo Drive Shown)

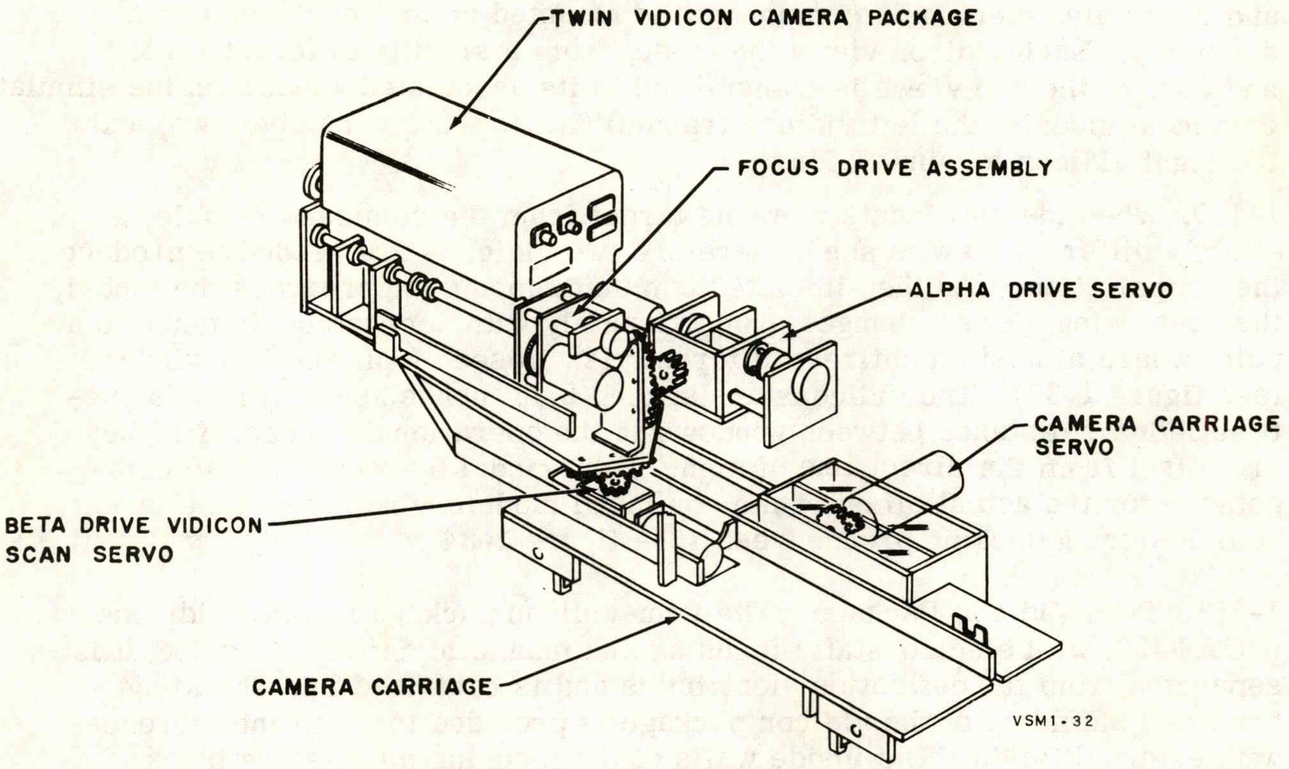


Figure 1-32. Vidicon Carriage Assembly

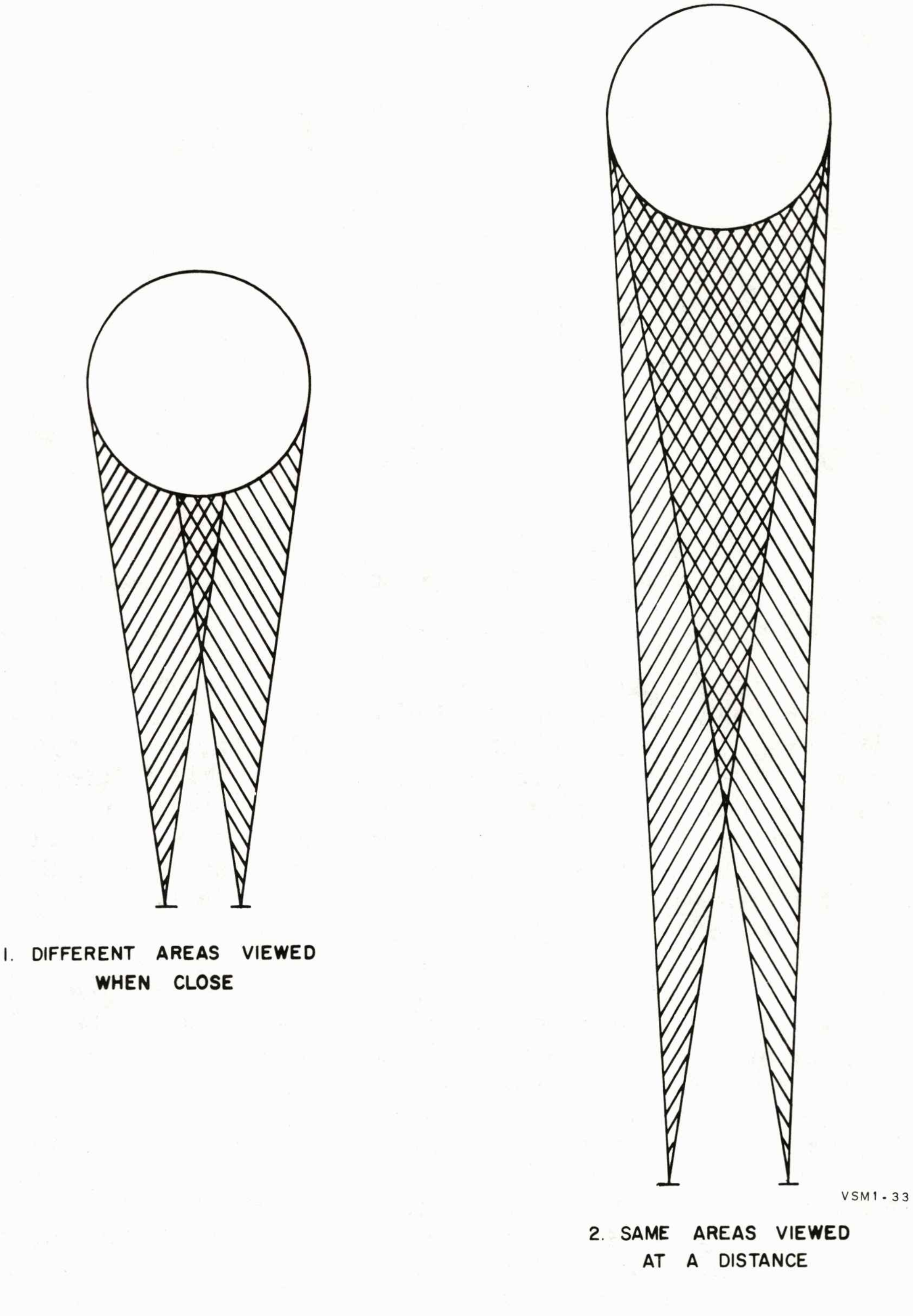


Figure 1-33. Change in Perspective Due to Distance Change

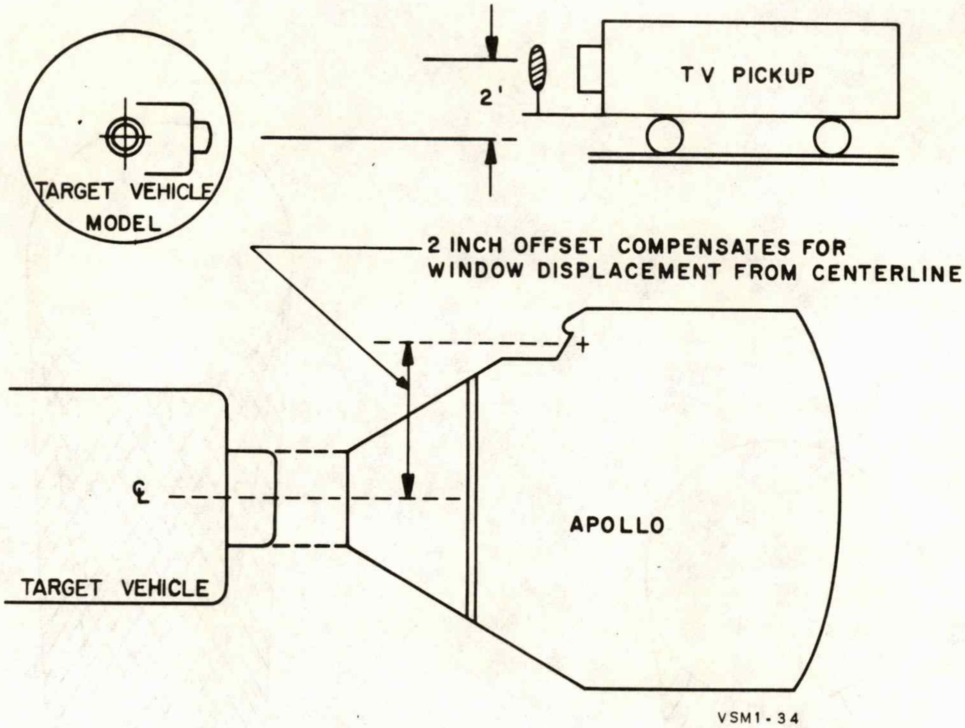


Figure 1-34. Offset Distance of TV Pickup to Model

1-152. Vidicon Coil Assembly. A vidicon coil assembly is installed which consists of two deflection coils and two alignment coils. They are mounted together with straps in a mounting fixture. The center distances of the coils are precisely adjusted to 2.45 inches. Several sheets of conetic material between the units increase the magnetic shielding properties of the individual coils. The coil assembly is interchangeable without disturbing associated parts or circuits. The electrodes of the vidicons are decoupled by an RF-filter. A printed circuit board located directly on each vidicon contains all the filter components, the socket, and wiring connections.

1-153. Two pre-amplifiers are used in this system. These small five-stage nuvistor amplifiers are mounted on an upright copper-plate above the coil assembly. Both amplifiers are connected via Winchester connectors to the power connectors at the rear of the camera housing.

1-154. The low level video signal from the target of the vidicon is applied to the grid of the first nuvistor triodes. They are used as a cascade amplifier with series and shunt peaking. Conventional tetrodes are used in the third and fourth stages. Both stages use cathode biasing and series shunt peaking, and all peaking coils are slug tuned for proper phasing and frequency response. The last stage is a cathode follower which uses a nuvistor triode for matching the coax cable impedance. The video output signal is fed to the processing amplifier in the control unit.

1-155. Camera Housing. (See figure 1-35.) The deflection electronics of both vidicons are located in two separated housings. Located in these housings are the necessary amplifiers for the horizontal and vertical drive pulse, horizontal and vertical size control, and the transformers for the coils. Yoke ringing is prevented by a clamp pulse during retrace. Horizontal and vertical linearity controls produce the correct voltage waveform required for a linear sweep. Horizontal and vertical centering controls are provided for adjusting the d-c current of the alignment coils in order to center the raster of each vidicon.

1-156. An insertion circuit is used to combine horizontal and vertical blanking pulses. These pulses are applied to the vidicon cathode to bias off the beam during retrace in both directions. This prevents retrace lines in the picture.

1-157. All variable controls for the camera electronics are mounted on the rear panel of the camera housing for easy adjustment. The camera housing contains the connector for the twin vidicon package as well as the video amplifier assembly, a main circuit board, and deflection circuitry.

1-158. Vidicon Positions. The relative position of the vidicons to the model is controlled by three servos labeled CAMERA CARRIAGE, ALPHA, and BETA. These three servos are all limited range servos and upon a signal from the computer, drive to the position commanded. The camera carriage servo controls the distance of the carriage from the model as it rides backward or forward on the track. The Alpha servo controls the elevation of the table on which the vidicons are mounted and can raise or lower the table six degrees in either direction. The Beta servo determines movement of the table left or right of the direct line of sight and is controllable six degrees in either direction. (See figure 1-36.)

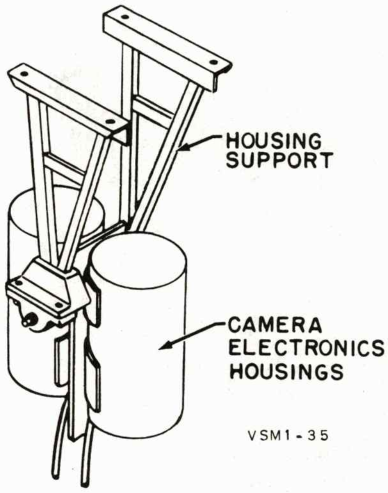


Figure 1-35. Camera Electronics Unit

1-159. Vidicon Focusing. A servo labeled FOCUS controls two focus lenses located firectly in front of the vidicons (see figure 1-37). Both lenses are controlled by the one servo and as the camera carriage moves closer to the model, the position of the focus lenses must change to keep the projected image in focus and from becoming blurred. The lenses are apochromatic wide angle lenses, especially corrected for a flat field and low geometric distortion over a 30 mm area. They cover an angular field of view of approximately 83 degrees. A summary of the major parameters and characteristics of the lenses are contained in table 1-14.

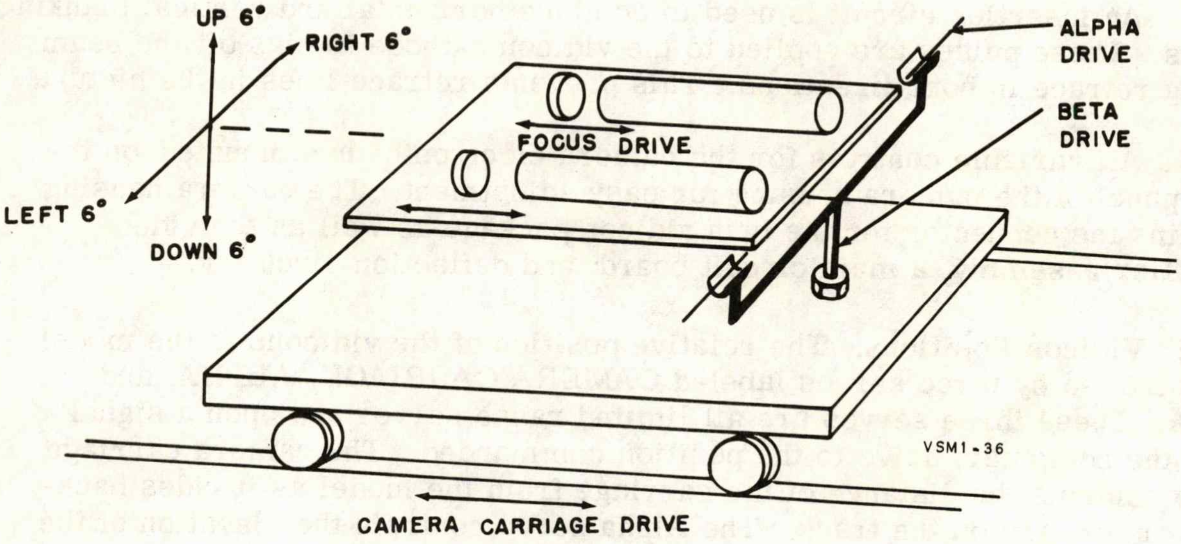


Figure 1-36. Vidicon and Carriage Degrees of Freedom

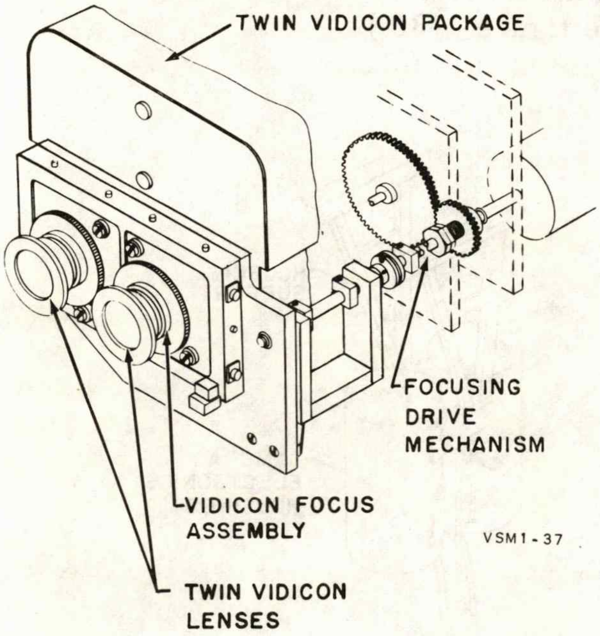


Figure 1-37. Vidicon Focus Lens Assembly

Table 1-14. Focus Lens Characteristics

Type of camera optics:	Apochromatic, camera lens, corrected for a flat field and low distortion over a 30 mm diameter.
Manufacturer:	Angenieux - Paris, France
Focal Length:	14.5 mm
Optimum F-number for maximum depth of field at the required resolution:	8-11
Manual F-stops provided:	From F/3.5 to F/22
Light transmission:	70 percent
Closest focus distance:	3.0", corresponding to 5 feet actual world
Total focusing travel:	4.5 mm
Eyepoint:	At close distances correct, at far distances unnoticeable closer to object.
Angular field:	Simulated field is approximately 83 degrees.

1-160. VIDEO EQUIPMENT CABINET (UNIT 7). (See figure 2-34.)

1-161. CONTROL AND MONITORING EQUIPMENT - CCTV. During a mission, the functions of the closed circuit television (CCTV) are ordinarily computer controlled, and come directly from the interface cabinet (unit 45). All signals, in addition to being auto/manual controlled, are fed through a set of four (6 PDT) relays (7A2A10). These relays provide an override capability and the system operation is controlled by the computer regardless of the prior position of the individual sub-system. Color coded indicator lights on the control panel in the video equipment cabinet (unit 7) denote the status of the individual controls as follows:

a. Red - Failure lights.

b. White - Automatic, override, monitor indicator.

c. Green - Display power on, sun and moon on.

d. Amber - Manual indications.

1-162. The video control and monitoring equipment consists of coaxial relay chassis 7A2A8, a section of relay chassis 7A2A10, and a section of control panel 7A2A2 (see figure 2-41). The section of the control panel used for control and monitoring is labeled DOCKING WINDOW SIGNALS, VIDEO SIGNAL, and MONITORS SIGNAL. A complete listing of all the controls on the control panel is give in table 2-42.

1-163. Coaxial Relay Chassis. The coaxial relay chassis (7A2A8) consists of four SPDT coaxial relays with two SPDT auxiliary contacts on each, and three DPDT coaxial relays. The coaxial connections of the SPDT switches are used to switch the four video inputs to the monitoring equipment, while one of the auxiliary sets of contacts is used to light an indicator (MONITOR SIGNAL) on the control panel.

1-164. Relay Chassis 7A2A10. The section of relay chassis 7A2A10 used consists of part of a SPDT relay and two DPDT relays, each with a 26-volt d-c operating voltage and a 2 ampere contact rating. These relays, in conjunction with the switches on the control panel, select automatic or manual control of the video channel selection and video ON/OFF. Also provided is the capability to override any manual control in the subsystem described.

1-165. Control Panel. The control and monitoring portion of the control panel consists of seven switch-lights of which three have the switch portion removed and are used solely as indicator lights. Pressing any of the remaining four operates the switch which controls the indicated mode of operation (i.e., RV/AUTO), or the video ON/OFF which affects the display shown in the SCM window. A rotary selector switch labeled MONITOR SIGNAL is also installed on this panel and controls the signal displayed on the monitor.

1-166. Beacon Generation and Control. The beacon generation and beacon control system, which is included for possible future configurations, consists of a power supply card, two binary counters, a delay multivibrator, a digital logic card, and two cable driver cards. These components are mounted on the right rear section of unit 7. The output of this generator will depend on the position of two relays (K4 and K5) on relay chassis 7A2A10. These relay positions will in turn depend on the positions of the switch lights labeled BEACON CONTROL RANGE and FLASH on the control panel.

1-167. The beacon generator output signals will be connected to the coaxial relay assembly and will be switches "in or out" depending on the BEACON RANGE switch. Under some conditions, the beacon signal will replace the camera signal as an input to the video processing and display chain.

1-168. Rendezvous Illumination Control. A-c power is supplied to or removed from the sun and earth lamps in the model house (unit 11) as a function of the position of illumination control relays in the power distribution cabinet (unit 61). These relay positions in turn are a function of three switches on the control panel marked **RENDEZVOUS ILLUMINATION CONTROL - AUTO/MAN, SUN MANUAL,** and **MOON MANUAL.**

1-169. The indicators on the control panel marked **SUN ON** and **MOON ON** are operated by the outputs of the respective illumination conditions sensing circuitry. This sensing circuitry consists of photo-relays for the earth light and of a resistor-relay combination for the sun light.

1-170. Model Position Control. The position signals (position of the model in the astronauts field of view) required are two per window and are either automatic (computer signals) or manual, depending on the position of an **AUTO/MAN** switch on the control panel. When the switch light under **POSITION CONTROL** denotes **AUTO**, the position of the model image is computer-controlled in both left-and right-hand windows. When the light indicates **MANUAL**, the model image position is controlled by a potentiometer on the control panel. The **POSITION CONTROL - HORIZONTAL** rotary control governs the movements of of the model image left and right of center, and the **POSITION CONTROL-VERTICAL** rotary control governs the movement above and below center. Both of these controls are needed for each window, therefore, there are a total of four potentiometers for manual positioning.

1-171. Model Range Control. For windows 2 and 4, the simulated range of the model image from a distance of 150 feet to 10,000 feet is controlled by the computer signal, when the respective **AUTO/SELECT AREA** switch on the control panel indicates **AUTO**. When the switch indicates **SELECT AREA**, the range may be controlled manually from the cabinet area or from the display area. This is determined by the position of the switch light directly to the right of the **AUTO/SELECT** switch on control panel. When control is in the cabinet area, the range can be varied manually for the respective windows (either simultaneously or separately) by varying the potentiometer mounted directly to the right of the **DISPLAY AREA/CABINET AREA** switch light. Turning this **RANGE** potentiometer counterclockwise decreases the range while clockwise movement increases the range. When control is in the display area, the range can be varied manually by a potentiometer labeled **TEST RANG ADJ** on the display area control panel.

1-172. Override/System Mode. The light labeled **SYSTEM MODE-AUTO/MANUAL** on the control panel indicates **AUTO** if every subsystem of the system is under computer control, but will indicate **MANUAL** if any of the subsystems are not under computer control and the **OVERRIDE** light is off. When the **OVERRIDE** switch-light is pushed, it illuminates, and the **AUTO/MANUAL** light extinguishes, putting all subsystems under computer control regardless of their previous condition. Pushing the **OVERRIDE** switch again causes all

subsystems to return to their previous conditions (if no other controls have been changed), and the **OVERRIDE** switch extinguishes.

1-173. Display Power Control. Two switch-lights control the power to the display areas. These switches, labeled **DISPLAY POWER ON-WINDOW 2** and **DISPLAY POWER ON-WINDOW 4**, enable and disable the power distribution to the display area. When the power is applied, the lights illuminate, thus indicating a power on condition for their respective windows.

1-174. Failure Indicators and Elapsed Time Meters. Four indicator lights (two for each window) illuminate if there is a failure in the deflection circuitry or a loss of the CRT biasing voltage in either window. The operation of the lights depends on signals generated in the sweep loss protection chassis in the display area electronics. Two elapsed time meters monitor the total amount of time that the high voltage is on (i.e., running time for the CRT's) for their respective areas.

1-175. High Voltage Indicator Lights. Two high voltage indicator lights (one for each display) are included on the control panel. These lights are illuminated when the high voltage is present in the display area.

1-176. Display Control System. (See figure 1-38.) Each camera control unit has two video outputs. Since there are four units, there are a total of eight video signals being fed into the switching chassis. Four of these signals (one from each of the camera control units) are routed to the monitoring equipment and are discussed in following paragraphs. Of the remaining four, two are for the left-hand window and two for the right-hand window. Each of these signals is approximately 0.7 volts peak for a large raster. The signals are all inputs, at one time or another, to the respective video preamplifier. During the simulation of a docked position, the combination of computer signals, and therefore relay positions, would be such that the signals to the display areas originate in the cameras which are viewing a pair of fixed slide pictures of the model. When simulation of SCM/target vehicle separation is desired, the signals from the slide cameras are removed, and the signals from the cameras viewing the target vehicle in the model house become the input to the video preamplifier.

1-177. Slide Image Generation. A high resolution television system is provided for possible future configurations. This system will provide image generation during the docked phase of a mission. The system includes a camera, camera control unit, power supply, and remote control panel. The camera is capable of 800-line resolution at a 1023 line scanning rate.

1-178. The projector assembly combines the television camera with a slide projector on a mounting fixture. Each can be removed from the cabinet for adjustment or service. The lens assembly for the slide pickup camera used during the docked configuration employs a high order correction lens. This

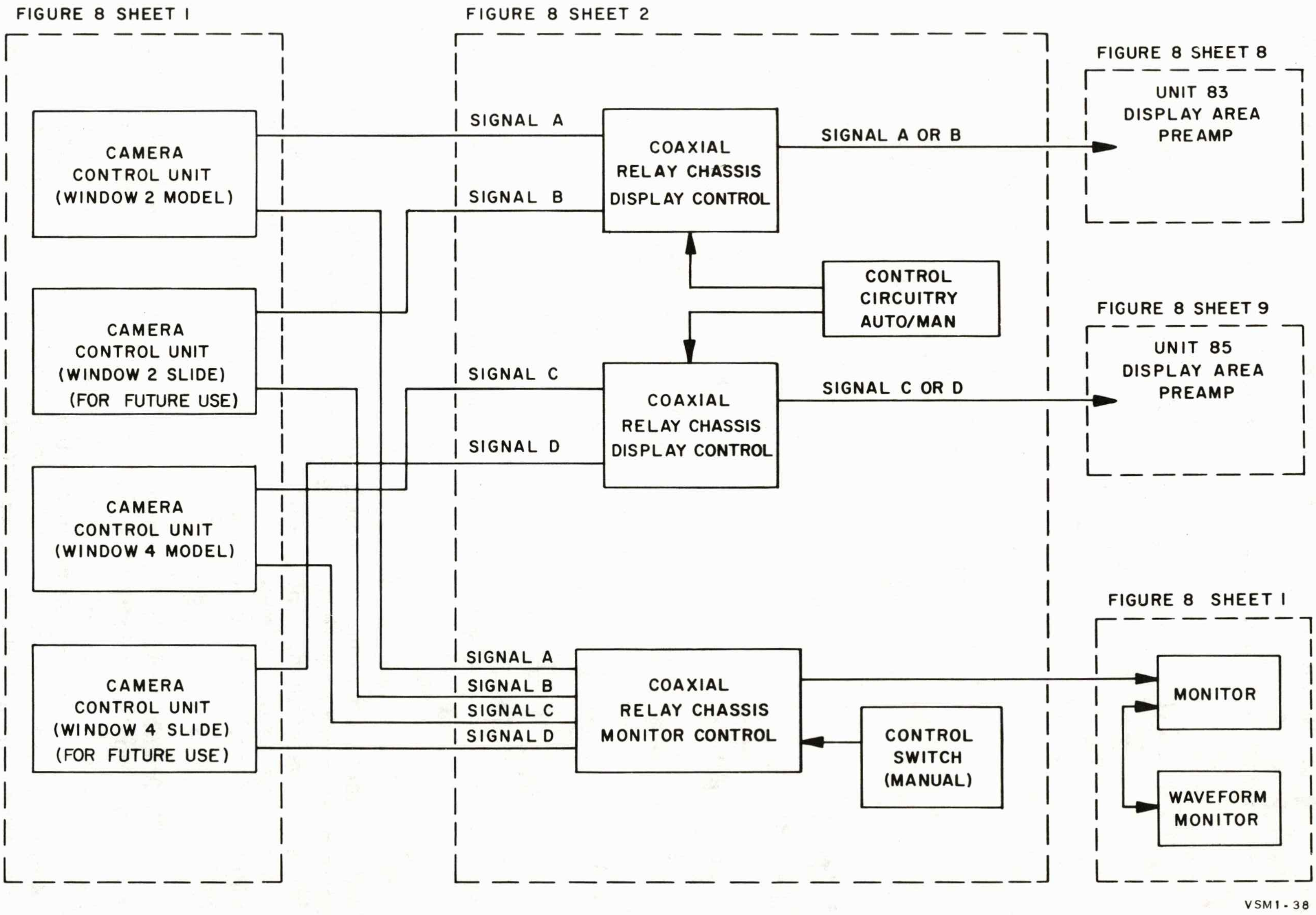


Figure 1-38. Display Control System

lens is installed in a non-focusing mount with a click stop iris diaphragm from F/4 to F/22. The lens is inserted into the projector via a mounting cylinder which provides the necessary focusing travel of 12 mm. A summary of the optical system parameters for the slide pichup is included in table 1-15.

Table 1-15. Slide Projector Optical System Parameters

Type of optical probe:	Highly corrected enlarger lens, airspaced, six glass elements, for flat fields and free of geometric distortion within a diameter of 16 mm.
Manufacturer:	Schneider - Kreuznach, Germany.
Coverage:	30 mm diameter.
Focal length:	28 mm
Optimum F-number	F/8
Manual F-stop provided:	F/4 to F/22
Vignetting:	Negligible
Light Transmission value:	70 percent

1-179. The camera contains the video preamplifier, the horizontal deflection circuits, sweep loss protection, vidicon blanking circuits, and the focus modulation for the vidicon. The preamplifier consists of a low level Cascade arrangement with low noise resistance and low input capacitance which provides high sensitivity. Two pentode stages are employed for gain and phase reversal.

1-180. The horizontal sawtooth generator with a power stage and transformer provides the horizontal deflection circuitry of the vidicon. The sawtooth generator circuit employs voltage feedback, and provides linearity of better than one percent. A protection circuit is used to prevent the vidicon from loss of horizontal and vertical sweep. Both sweep voltages are rectified and amplified to control the vidicon voltage so that if either drops below a given value, the beam will be cut off.

1-181. Television Camera Control Unit. The modified video processing amplifier has gain stages, mixer stages, and a phase reversal stage which will provide the desired video polarity (positive or negative polarity as determined by a switch). Several video amplifier stages are provided for adjusting the high frequency and low frequency response through slug tuned peaking coils. In addition, the unit contains focusing and black level adjustments and two cathode follower output stages which are used as cable drivers. An aperture control provides compensation for the losses within the vidicons due to aperture distortion. A sweep loss protection circuit protects the vidicon. A modified video amplifier chain in the control unit provides an automatic gain control of about 20 db. An automatic gain control amplifier is contained on a printed circuit card and is installed in the camera control unit. The 3 stage automatic gain control amplifier is computer controlled by D/A signals of plus or minus 10 volts.

1-182. A remote control panel for each camera is installed in unit 7 and allows adjusting of the focus, target beam, horizontal and vertical size, horizontal and vertical centering, gain, and black level. Performance characteristics of the camera are given in table 1-16.

Table 1-16. Camera Performance Characteristics

Field rate	60 cps
Frame rate	30 cps
Interlace	2:1
Lines per frame	1023
Bandwidth	20 mc - 3 db
Aspect ratio	4:3
Horizontal resolution	1000 center, maximum 700 corner
Vertical resolution	600 center
Geometry	plus or minus 1 percent
Gray scale	10 shades on EIA resolution test pattern
Signal to noise	40 db
Auto exposure	400:1
Aperture correction	0 to 10 db at 10 mc

1-183. Monitor and Waveform Monitor. Regardless of which video signal is being displayed to the astronaut, the monitors may observe any one of the four signals from the camera control units. This is accomplished by using 4 coaxial relays whose common terminals are connected, and whose input terminals are connected either to a signal from 1 of the camera control units (normally open contact) or a 75 ohm terminating resistor. The selection of the video signals is controlled by a rotary switch whose arm is connected to 28 volts dc. Regardless of the position of this switch, 1 of the signals is connected to the monitor and the remaining 3 are terminated at the 75 ohm resistor.

1-184. The monitors are used to make the four camera control outputs compatible with respect to black level, video gain, percent modulation, horizontal and vertical linearity, etc., so that a shift from the slide to the model, for instance, would not be disturbing to the astronaut. Two monitors are provided. The Conrac CQC-17/C TV monitor is used mainly to give a "feeling" for the displayed image. The Tektronix RM-527 Waveform Monitor (MOD 404 G modified for 1023 line system) is used for setting black level, video gain, focus, etc.

1-185. Since the range variation from 150 feet to 10,000 feet is simulated by shrinking the raster (see figure 1-39) and command module attitude relative to the center of the model is simulated by shifting the raster, these areas of the simulation will not be seen on the monitor. Range variation from 5 feet to 150 feet will be seen however, as will any changes in perspective at close range (Alpha and Beta movement of the vidicon only). Generally, the image displayed to the astronaut is of better quality than that indicated by the monitors since the bandpass of the display circuitry goes to 30 mc while both the Conrac and Tektronix go only to 18-20 mc at the high end.

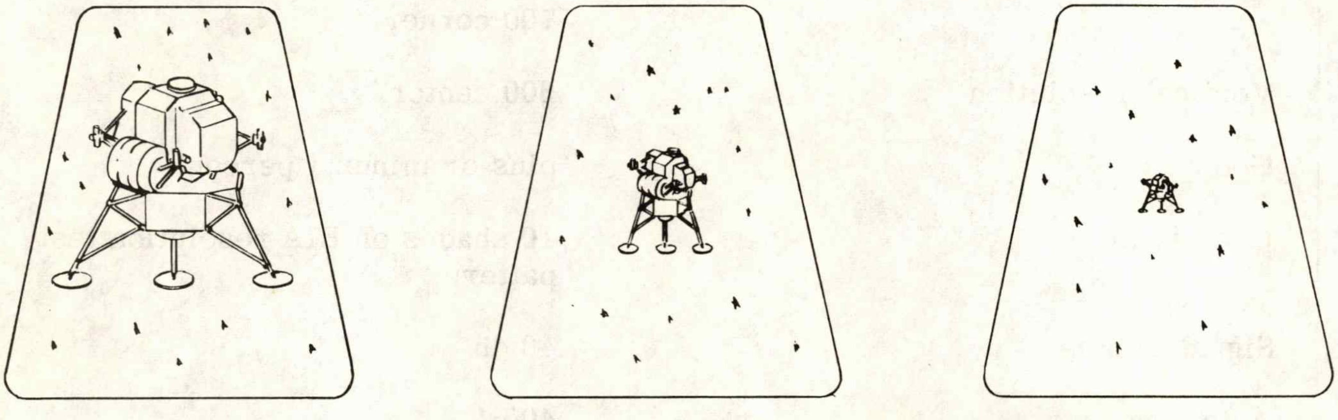


Figure 1-39. Raster Shrinking Effect

1-186. Beacon Generator. The beacon generator (provided for possible future simulations) utilizes an 8 bit binary counter from which the 256th line of each field scan may be located. At the beginning of this line trace on the CRT, a 200 microsecond and 15 microsecond monostable multivibrator are triggered. During the period of the 200 microsecond, the horizontal drive pulse for each line retriggers the 15 microsecond multivibrator. The trailing edge of each 15 microsecond output triggers a 1 microsecond multivibrator. The one microsecond output pulse is fed through an emitter follower to a coaxial relay switch. A block diagram of the electron beacon is shown in figure 1-40.

1-187. Illumination System. (See figure 1-41.) Model illumination consists of two 400-watt mercury vapor lamps representing the sun and four 400-watt mercury vapor lamps representing reflected light as was previously discussed. The state of these lamps (on or off) is controlled by two relays in the power distribution cabinet. Because of the length of time required to bring these lamps to maximum light level (six to eight minutes), the ON signal is programmed so that the DBO step occurs at least this length of time prior to viewing the model. During this time the video ON/OFF signal may be used to remove power from the preamplifier (refer to paragraph 1-168). This interruption in the video chain causes the amplifiers to sit at their quiescent condition and the CRT is biased off (black). Because of the limitation of 55 degrees in the sun translational servo, rendezvous with the sun directly in front of or behind the SCM windows is not possible.

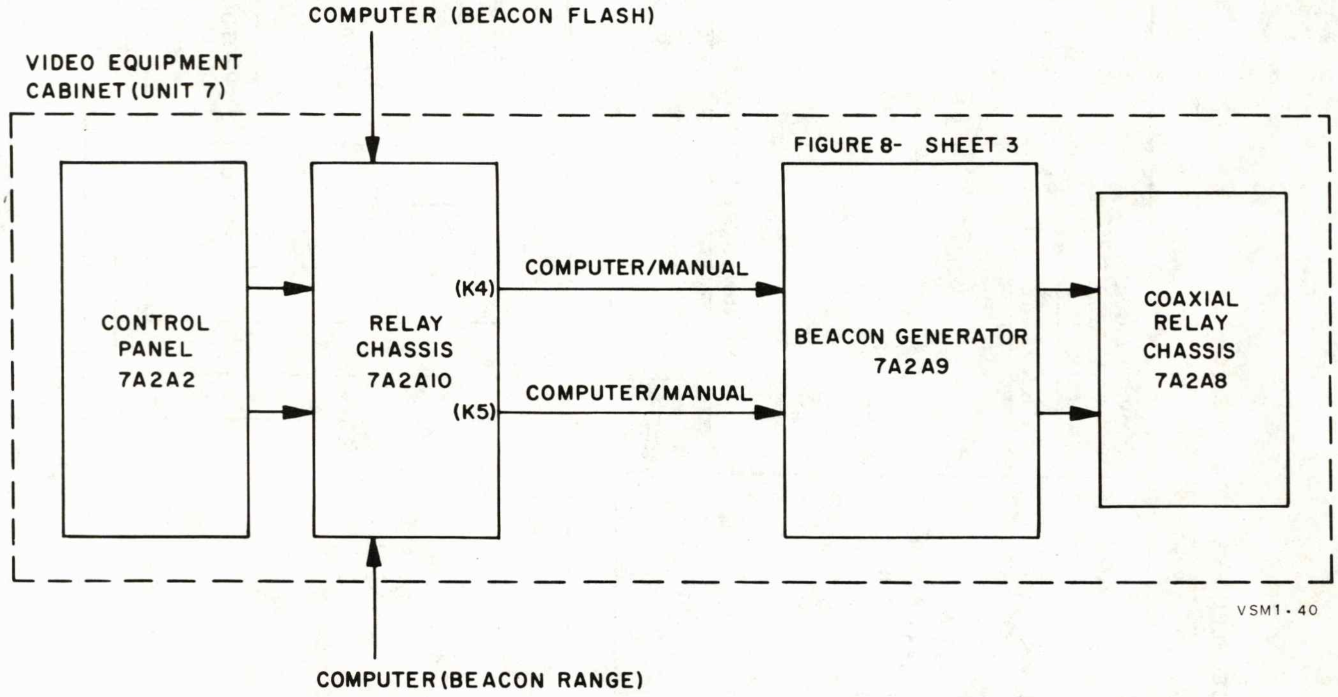


Figure 1-40. Electron Beacon Block Diagram

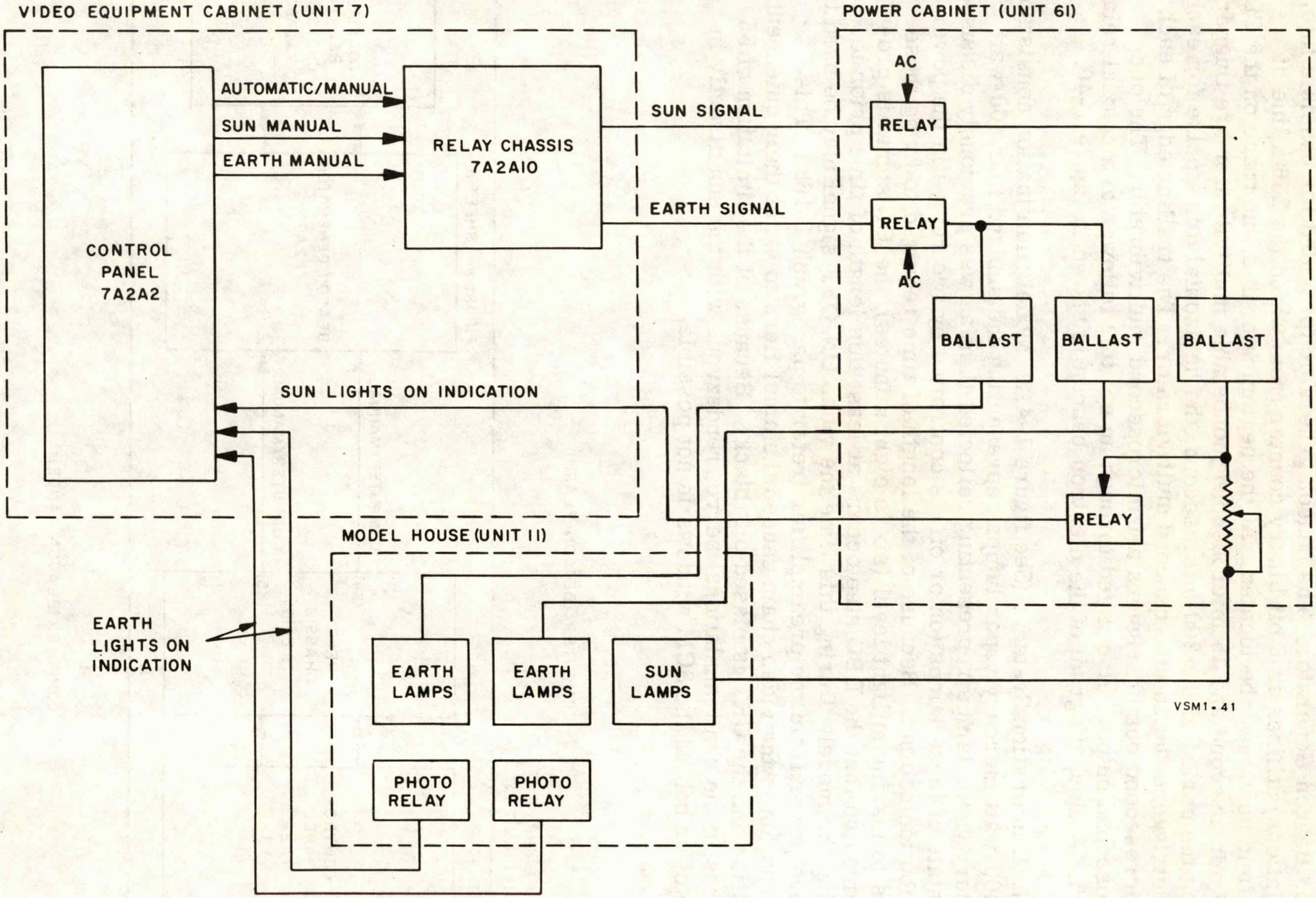


Figure 1-41. Illumination System Block Diagram

1-188. Video On/Off Signal. When the range of the target vehicle is greater than 10,000 feet, or it goes out of the FOV in any direction, the video signal to the CRT must be removed so that the face of the tube is black. To accomplish this, the computer signal (DBO), called the video on/off signal, receives 28 volts dc and simultaneously removes power from the preamplifiers in both windows by operating a DPDT relay in each display area.

1-189. Range Control System. (See figure 1-42.) Simulation of range variation from the docked position (5 feet) to 10,000 feet is handled in 2 different modes. In the range between 5 feet and 150 feet the range simulation is accomplished by varying the distance of the vidicon pickup tubes from the target model in the model house. During this movement, the lens in front of the vidicon is focused by a servo system. At the same time, the CRT translational drive servo moves the CRT closer to or further from its infinity image plane, depending on whether the range is increasing or decreasing. (See figure 1-43.) This is required since an object in the infinity image plane will be displayed without any perspective. But if an object is, for instance, 25 feet away it should exhibit parallex. The CRT drive is approximately 4.8 inches of travel.

1-190. Simulation of range variations between 150 feet and 10,000 feet is accomplished by changing the size of the raster displayed on the CRT face where the largest raster (approximately 20.1 inches square) corresponds to 150 feet range and the smallest raster (approximately 0.31 inch square) corresponds to 10,000 feet in range.

1-191. Position Control System. (See figure 1-44.) The position of the target vehicle in the command module window is controlled by shifting the raster on the face of the CRT. Computer signals called X-decentering and Y-decentering vary from plus 10 volts d-c to minus 10 volts d-c where 0 volts corresponds to the target being exactly in the center of the CRT. Plus 10 volts d-c corresponds to the raster being off the CRT face at the top for the vertical decentering and to the right for the horizontal decentering. The reverse is true for the minus 10 volts condition.

1-192. The computer signal inputs fed into the d-c current amplifiers in the display electronics generate a slowly varying current in the deflection coils as the input signal varies. This signal is added to the horizontal deflection coil through an RF choke, since the high frequency deflection current must be preserved. In the vertical deflection coil, the components are more easily combined. The deflection waveforms are essentially riding on direct currents and the fields that are set up also have the d-c and a-c components. The a-c components continue to form the raster but the direct current causes the raster to be shifted an amount corresponding to the direct current component. This simulates a change in the target position.

1-193. When the raster is decentered (consider a large raster) some of the TV lines and parts of other TV lines are "pushed off" the face of the CRT.

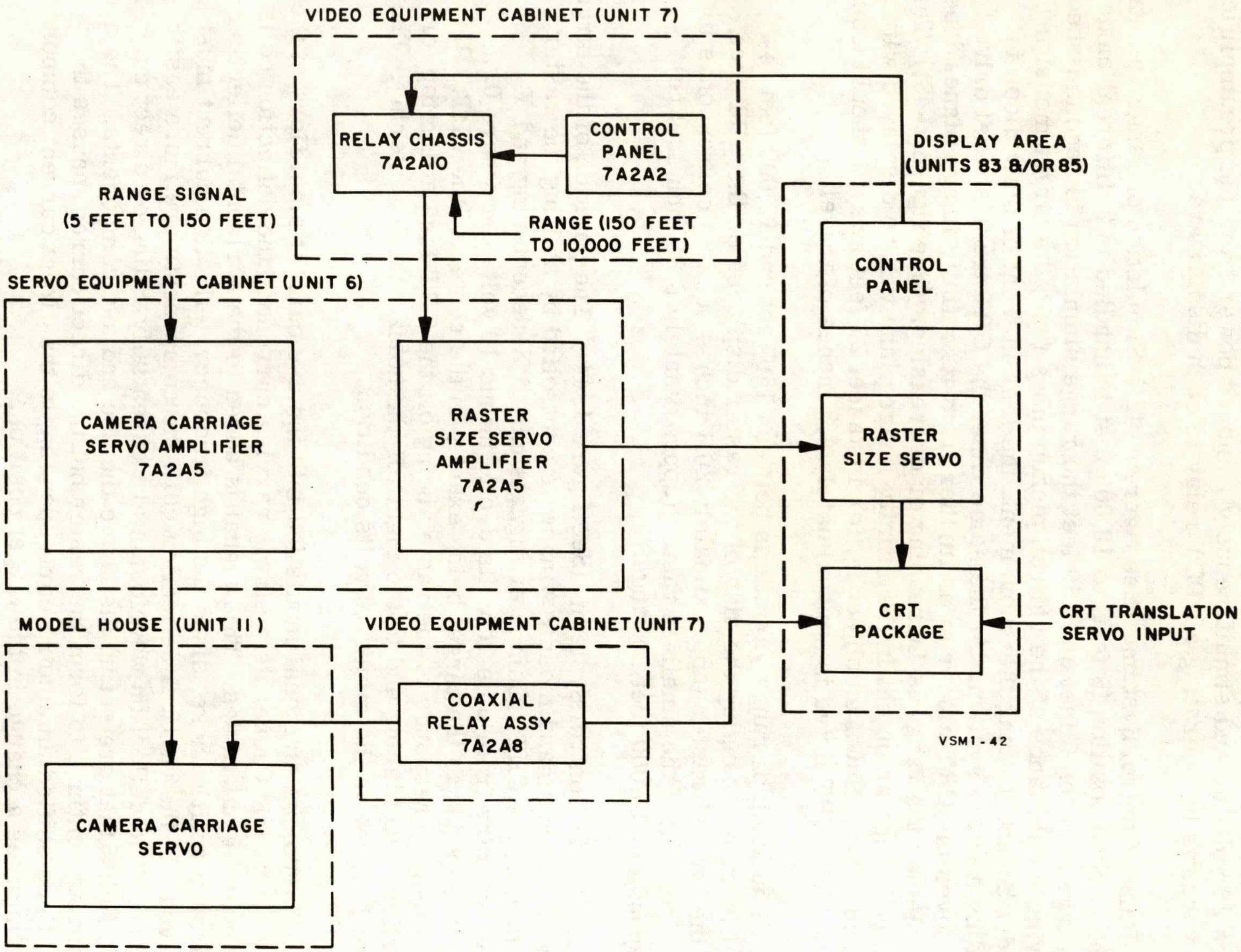


Figure 1-42. Range Control Block Diagram

This is known as "blanking." If there is any signal contained in these lines (i.e., if any appreciable beam current is flowing) the possibility of having reflections off the funnel exists, therefore, any video information during this time must be removed.

1-194. Current sensing resistors sample the deflection currents, and their output voltages go to squared generator cards (Y^2 for vertical, X^2 for horizontal) where they are added, thus giving the distance of the raster center from the zero decentering point. The adder output is compared with the size and position of a centered raster. When the comparison indicates that some of the raster lines are off the face of the CRT, an output signal is generated (pulse one volt peak).

1-195. The pulse width varies with the length of time to be blanked for each line. This output pulse is introduced in the camera control unit via a gating circuit and adds to the television blanking time. The video signal is blanked for this period of time and the CRT beam current is negligible.

1-196. In addition to displaying a slightly decentered raster where a portion of the video information is blanked, pitch, yaw, or a combination of the both can be simulated. For example, a forward pitch of the command module would cause the target to appear to move out of the FOV at the top of the windows and come into the FOV again at some later time (depending on the rate of pitch in degrees/second).

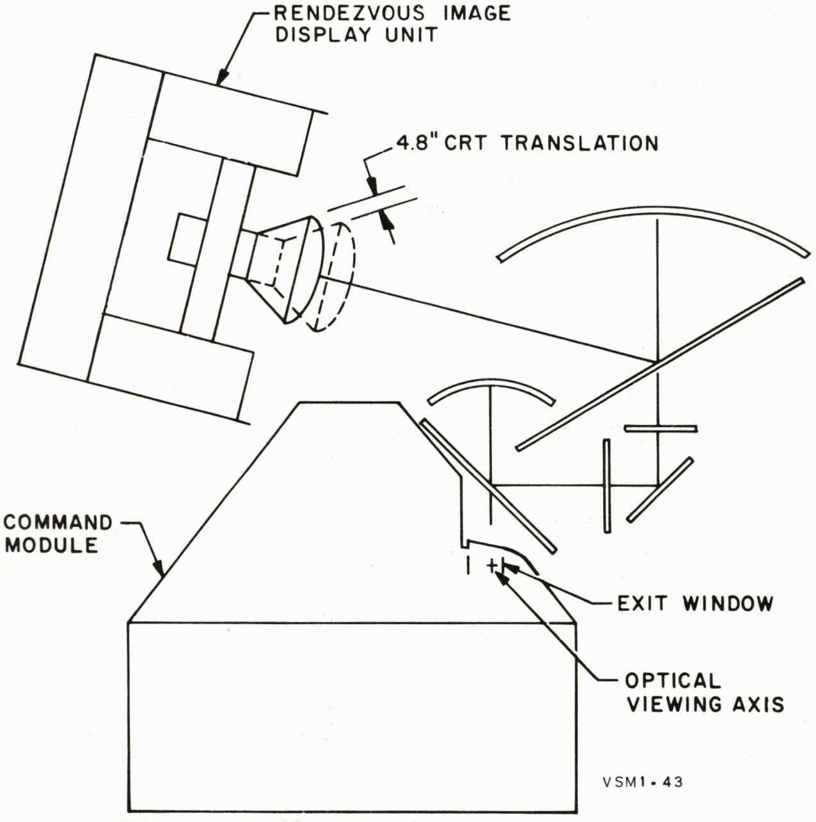


Figure 1-43. Rendezvous Image Input

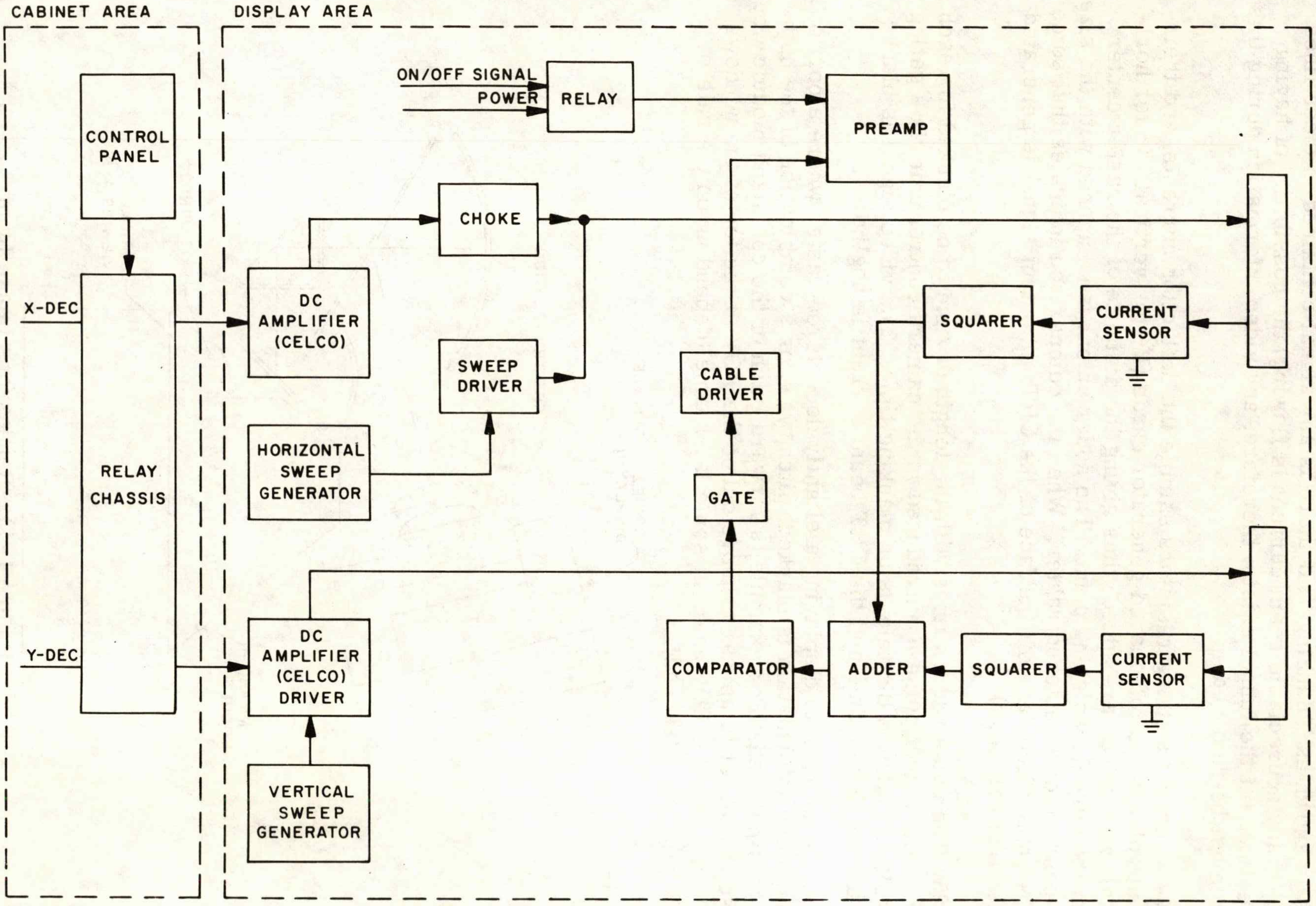


Figure 1-44. Display Position Control Block Diagram

VSM1-44

1-197. Because of the large d-c current required to completely decenter the raster, the life of the deflection coils decreases if this current is maintained for any extended period. To limit this current to a minimum, while still having the capability required for simulation, the video on/off signal is programmed to be dependent on the horizontal and vertical decentering signals. When the raster is decentered off the screen, the on/off signal (DBO) removes power from the preamplifier in both windows. Under these conditions the raster may be centered (decentering signals at zero volts d-c and no d-c deflection currents), but since there is no signal, the target is still out of the field of view (FOV) with respect to what the astronaut sees. At the proper time (depending on the rate of SCM pitch) the decentering signals assume polarities opposite to the previous condition, and the power is again applied to the preamplifiers. As the decentering signal becomes smaller (absolute value), the target moves back into the FOV from the side of the window opposite the side it left the FOV, therefore simulating a 360 degree movement of the SCM.

1-198. SERVOS

1-199. The servos used in the AMS are mounted on plug-in cards and require various numbers of card slots depending on the type of servo. The servos are standard, basic servo cards with various potentiometers, synchros, resolvers, clutches, etc. mounted on the card, depending upon the function the servo is to perform. Each servo plugs into a standard 34 pin connector at the rear of the card rack and has a handle at the front.

1-200. SERVO CABINET (UNIT 6). The servo cabinet (see figure 2-43) contains the electronics for the servo assemblies. Cables to the various servo assemblies originate in this cabinet and carry the signals and power required for servo operation. Two proper supplies, a minus 30-volt and a plus 30-volt, provide the current and voltage to the power amplifiers which drive the motors. Plus and minus 50-volt power supplies provide the voltages for all other amplifiers. Reference voltages for the potentiometers are provided by a plus 10-volt power supply and a minus 10-volt power supply.

1-201. The cabinet also contains a relay panel. Relays provide a time delay of 3 minutes for applying the plus or minus 30 volts, and an interlock insures both voltages are on. Relays also provide one signal to the instructor's console indicating a failure in any one of the power supplies.

1-202. Maintenance Panel. An automatic-manual switch is provided on the maintenance panel (see figure 2-48) for each servo and permits operation of the selected servo either from the computer signal or from an adjustable potentiometer signal. Test points are provided for each servo and allows voltages to be measured at various points in the servo loop. All the amplifier cards and summing cards are the plug-in type and are accessible from the front of the cabinet. Table 2-49 gives a complete listing of the maintenance controls and their function.

1-203. POWER

1-204. VIDEO POWER EQUIPMENT CABINET (UNIT 8). The a-c power for the entire video system (including power supplies and display area power requirements) is supplied from a 120-volt a-c, 52 ampere capacity power regulator (Stabiline-Superior Electric) located in unit 8. (See figure 2-49). The 120-volt 60-cps output from the regulator is used as a power source for 8 power supplies required in the display area electronics as well as satisfying the power requirements of the image generation equipment (4 camera chains, monitors, sync generator, beacon generator, and relay power).

1-205. The a-c power comes from the regulator to the distribution panel and is routed from there to the various power supplies in unit 8. From unit 8, power is further distributed to unit 7 and then to the display area. In some cases a-c power is distributed through relay 8A1A2 so that the proper sequencing of d-c turn-on is achieved.

1-206. D-c voltages generated in unit 8 are routed to the d-c distribution panel and sample leads are routed to the relay panel. The sample leads (one for each supply) operate relays which cause a "power on" indication at the IOS. If one d-c voltage is lost in the visual area, the associated relay opens and generates a "fail" signal to the IOS. The d-c is distributed to unit 7 and then on to the display area. Besides the 120 volts ac, 28 volts dc is used in the cabinet area for relay operation power and manual signals. Plus and minus 10 volts dc is also used, but is generated in unit 6 and then routed to unit 7.

1-207. POWER CABINET (UNIT 61). The visual equipment is designed to operate from 120/208 volts three phase, 4-wire, 60 cps, and 115 volts single phase, 2-wire, 400 cps. The a-c power is the various visual system cabinets (see figure 1-45) with the exception of the air compressor, is supplied via visual power cabinet unit 61. (See figure 2-56). An a-c power control panel (see figure 2-58), consisting mainly of pushbuttons and indicator lights, is installed in this cabinet and is used to control all a-c power to the visual systems.

1-208. Master Visual Power. When AMS primary power sequencing is in the independent mode, the power to unit 61 can be turned on or off by pressing the appropriate ON or OFF switch on the control panel. When the MAINTENANCE IN PROGRESS light is illuminated, the power is automatically turned off to the visual power cabinet, and cannot be turned on from this panel. A complete listing of each switch located on the a-c control panel and its function is given in table 2-59.

1-209. A relay chassis, installed in the power cabinet, contains all the relays used in connection with the circuitry for the cabinet. A phase interlock insures that power cannot be turned on to any of the visual cabinets unless all 3 phases of the 60-cycle power are present in the power cabinet. If any of the three phases fail in the power cabinet, the power to the complete visual system will be turned off automatically.

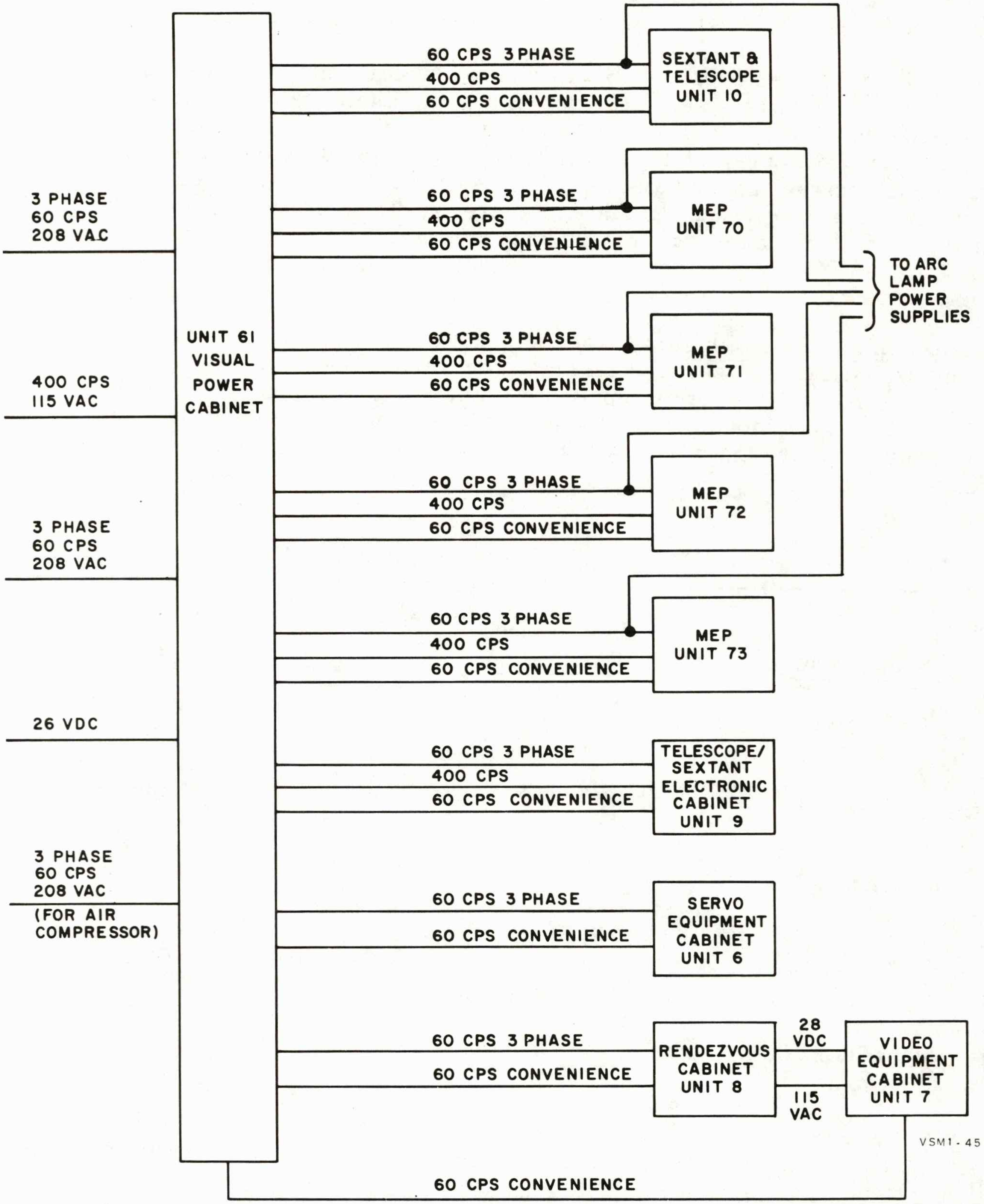


Figure 1-45. Power Distribution

1-210. D-C POWER SUPPLIES. There are 36 power supplies utilized in the visual system and are contained in various equipment cabinets.

1-211. Unit 6 Power Supplies. Six d-c power supplies are contained in the rendezvous and docking servo cabinet (unit 6) and their major characteristics are listed in table 1-17. The plus and minus 30-volt d-c power supplies are interlocked to prevent any power from being applied to the servo motors unless both power supplies are on. A three-minute time delay after initial turn-on of the power supplies allows the preamplifiers and power amplifiers to stabilize before the servo motors are energized.

1-212. Unit 8 Power Supplies. The video power cabinet (unit 8) is the primary distribution source of all ac and dc for the video system. The characteristics of the power supplies contained in this cabinet are listed in table 1-18. A sequencing circuit insures that the minus 200-volt d-c bias supply is on before the two plus 300-volt d-c 1.5 ampere supplies are energized.

Table 1-17. Power Supplies Unit 6

Unit Nomenclature	Reference Designation	Rating	Remarks
Power Supply	6A1A2	18-36vdc at 0-125a	Adjusted to -30vdc
Power Supply	6A1A3	18-36vdc at 0-125a	Adjusted to +30vdc
Power Supply	6A1A4	0-160vdc at 0-3a	Adjusted to -50vdc
Power Supply	6A1A6	0-160vdc at 0-3a	Adjusted to +50vdc
Mask Reference	6A1A6	0-15vdc at 0-5a	Adjusted to -10vdc
Slave Reference	6A1A7	0-15vdc at 0-5a	Adjusted to +10vdc

1-213. Unit 9 Power Supplies. The power supplies contained in the telescope/sextant electronics cabinet (unit 9) provide the necessary power required by the other associated electronics assemblies. Table 1-19 lists the major characteristics of each power supply.

1-214. Units 10, and 70 through 73 Power Supplies. The window display electronic cabinets (units 70, 71, 72, and 73) and the telescope cabinet (unit 10) each contain three power supplies. The window display units contain identical power supplies and are listed in table 1-20. A listing of the power supplies and their characteristics for unit 10 are contained in table 1-21.

Table 1-18. Power Supplies Unit 8

Unit Nomenclature	Reference Designation	Rating	Remarks
Power Supply	8A2A1	110-325vdc at 0-1.5a	Adjusted to +300vdc
Power Supply	8A2A2	110-325vdc at 0-1.5a	Adjusted to +300vdc
Power Supply	8A1A4	110-325vdc at 0-5a	Adjusted to -200vdc
Power Supply	8A2A3	0-36vdc at 0-5a	Adjusted to +36vdc
Power Supply	8A1A5	0-36vdc at 0-5a	Adjusted to +36vdc
Power Supply	8A1A6	0-36vdc at 0-5a	Adjusted to -36vdc
Power Supply	8A2A7	0-36vdc at 0-5a	Adjusted to -36vdc
Power Supply	8A2A8	0-36vdc at 0-5a	Adjusted to +28vdc
Power Supply	8A2A4	+300vdc at 0-.75a	Adjusted to +300vdc
Power Supply	8A2A5	+300vdc at 0-.75a	Adjusted to +300vdc

Table 1-19. Power Supplies Unit 9

Unit Nomenclature	Reference Designation	Rating	Remarks
Power Supply No. 1	9 PS1	0-36vdc at 0-25a	Output adjusted for +28vdc
Power Supply No. 2	9 PS2	0-15vdc at 0-50a	Output adjusted for +12vdc
Power Supply No. 3	9 PS3	0-15vdc at 0-50a	Output adjusted for +26vdc (used as a low level preamp)
Power Supply No. 4	9 PS4	0-15vdc at 0-5a	Output adjusted for -12vdc

Table 1-20. Window Display Power Supplies (Units 70, 71, 72, and 73)

Unit Nomenclature	Rating	Remarks
Power Supply	+18-36vdc at 0-125a	Adjusted to +28vdc
Power Supply	0-15vdc at 0-5a	Adjusted to -10vdc
Power Supply	0-15vdc at 0-5a	Adjusted to -10vdc

Table 1-21. Telescope Cabinet (Unit 10) Power Supplies

Unit Nomenclature	Rating	Remarks
Power Supply	18-36vdc at 0-125a	Adjusted to +28vdc
Power Supply	0-15vdc at 0-5a	Adjusted to +10vdc
Power Supply	0-15vdc at 0-5a	Adjusted to +10vdc

1-215. Plus Or Minus 10-Volt D-C Reference Power Supplies. The system voltage programmer, which is a 10 volt d-c power supply, is located in unit 67 and is used as the master reference power supply to which all of the visual reference power supplies are slaved.

1-216. Master Slave Tracking Pair. A master-slave tracking pair is a system consisting of two 10-volt d-c power supplies, one is minus (master) and the other plus (slave). The plus supply is slaved to track the minus supply and the minus supply is slaved to track the system voltage programmer. Such master-slave tracking pairs are used in units 6, 10, 70, 71, 72, and 73. Separate twisted shielded pairs (No. 16 wire) run directly from unit 67 to these units and the shields are grounded in unit 67.

1-217. Interlock. When turning on the master-slave tracking pair it is necessary that the system voltage programmer be on first. The 120 volts a-c is then applied simultaneously to both power supplies. If the system voltage programmer fails, all the slaved "master-slave tracking pairs" drop out. To switch a pair back on, both the minus and the plus supplies must be switched off and then back on simultaneously. If either of the master-slave tracking pairs fail, both supplies drop out. To switch them back on, follow the above procedure.

1-218. A-C POWER DISTRIBUTION.

1-219. 60-Cycle And 400-Cycle Power. The primary 60-cycle and 400-cycle power is utilized in the operation of all visual equipment. Primary operating power, from units 32 and 33 to unit 61, is distributed from bus bar subassemblies to the various contactors which control the a-c power to all visual cabinets.

1-220. Window Display Power. The electronic cabinet (unit 70) and the arc lamp power supply cabinet (unit 89) correspond to landing window No. 1. A-c power is controlled and distributed to these two units. Three phases of the 60-cycle power are taken from the bus bar subassembly and fed through a 75-ampere contactor whose coil is activated or deactivated by a pushbutton switch mounted on panel A1A2. The output of the contactor is fed through 2 sets of circuit breakers, 1 set of which is used to feed power to unit 70 and the other to feed power to unit 89. The 400-cycle single-phase power is taken from the bus bar subassembly and fed to unit 70 through a 60-ampere contactor and a 30-ampere circuit breaker. An indicator light labeled "POWER WINDOW #1" illuminates after the 400-cycle contactor is activated.

1-221. A-c power is distributed to the electronic cabinets and arc lamp power supply cabinets associated with rendezvous and docking windows two and four, the landing window number five and the telescope. Circuitry for these cabinets is similar to that described for landing window number one and therefore not discussed .

1-222. Telescope And Sextant Display Power. The distribution and control of the a-c power to the telescope and sextant cabinet (unit 9), the rendezvous and docking servo cabinet (unit 6), and the video power cabinet (unit 8) is quite similar to the distribution and control of the previously mentioned cabinets. Section VIII contains schematics which show how the a-c power is distributed for each of the three cabinets. The rendezvous and docking servo cabinet uses as primary power only the three phase 60-cycle power.

1-223. Convenience Power. The 120-volt three-phase, 4-wire, 60-cycle convenience power is separated from that of the 60-cycle operating power. Power is taken from unit 37 and brought to bus bar subassembly A2A3 of unit 61. From the bus bar subassembly through 10 ampere circuit breakers, the utility power is distributed to all visual cabinets, the model house, and to various locations on the window display structures. The power is distributed in such a manner as to keep the three phases balanced as much as possible. The output from each convenience plug is 120 volts single phase.

1-224. GROUNDING. All ground returns are available as separate isolated tie points in each cabinet, however, there are cases where two grounds are tied together within a chassis or subassembly. In cases where this is done, it is a design requirement of a circuit, otherwise the circuits cannot perform.

1-225. The three-phase, 4-wire, 120/208 volt power ground is isolated from the other grounds and its return wires are sent separately back to the simulator. The single-phase, 2-wire, 115-volt power ground and the convenience power ground are also isolated from the rest of the grounds and sent back separately to the central ground point of the simulator.

1-226. All chassis grounds within a cabinet are brought to one common bus bar and a wire from each cabinet, labeled chassis ground, is sent to the central ground point of the simulator. All shield grounds within a cabinet are connected to one common bus bar and in all cases this bus bar is jumpered to the chassis ground within each cabinet. In other cases, only the 115-volt 400-cycle shield from each cabinet is sent separately from the chassis ground to the central ground point.

1-227. The plus or minus 10-volt d-c power supply ground is routed to a central ground point in the cabinet by a separate wire. There it incorporates all other power supply returns and is sent separately to the central ground point of the simulator. These grounds are sent separately from each cabinet to the simulator central ground point, where it is used as the return ground for all DBO signals. The video ground also returned separately to the central ground point of the simulator.

1-228. INTERFACE.

1-229. INTERFACE SIGNALS. The interface is the electronic equipment which ties together the visual system to the data conversion equipment. Mainly, there are four types of signals that the visual system requires. The digital-to-resolver (D/R) signal (see figure 1-46) is a sinusoidal signal used in driving high accuracy servo systems and employs resolvers for feedback elements. The digital-to-analog resolver signal (see figure 1-47) is also a sinusoidal signal which is used in driving less accurate servo systems. These systems also employ resolvers as feedback elements. The third type signal, the digital-to-analog (D/A) signal (see figure 1-48) is an analog servo system employing potentiometers as feedback elements. The digital-bit-output (DBO) signal (see figure 1-49) is used for time sequencing and on-off type signals. Two digital word outputs (relay) (DWORs) are used. One drives the starfield selection servo drive for the sextant and the other drives the slide selection servo. A listing of the various signals and the quantity of each is given in table 1-22.

1-230. The visual status indicator signals are interfaced with the instructor's console. These signals are generated by the various systems to indicate to the instructor the general status of the complete visual system. They consist of computer-manual servo position signals, lamp fail signals, air compressor fail-safe signals, rendezvous display sweep loss signals, a 400-cycle power fail signal, and a d-c power fail signal.

1-231. INSTRUCTOR-OPERATOR STATION.

1-232. The instructor-operator station (IOS) contains seven consoles arranged in three major sections. The center straight console is flanked by a wing console at each end set at a 45 degree angle from the center console. Each of the three major sections is composed of individual panels which are further divided into sub-panels. Three of the sub-panels contain switches, controls, and indicators affecting either directly or indirectly the visual equipment. A complete listing of the components, their location, and function is found in the Basic Maintenance Manual, Volume I.

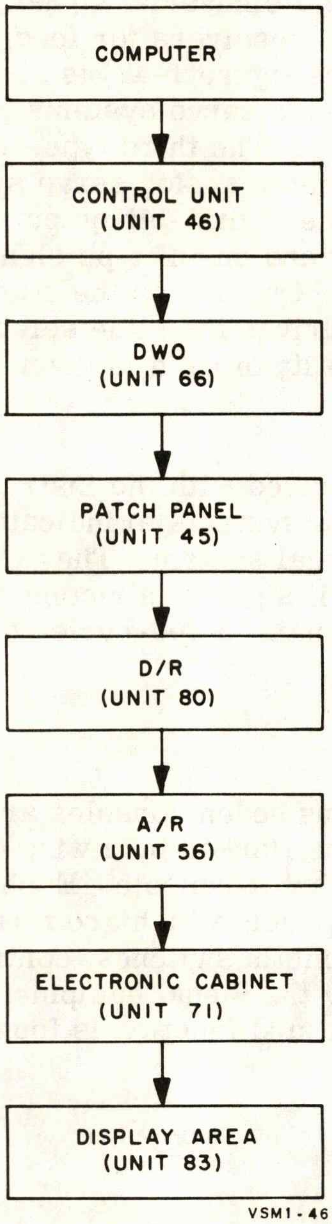


Figure 1-46. Typical D/R Signal Flow

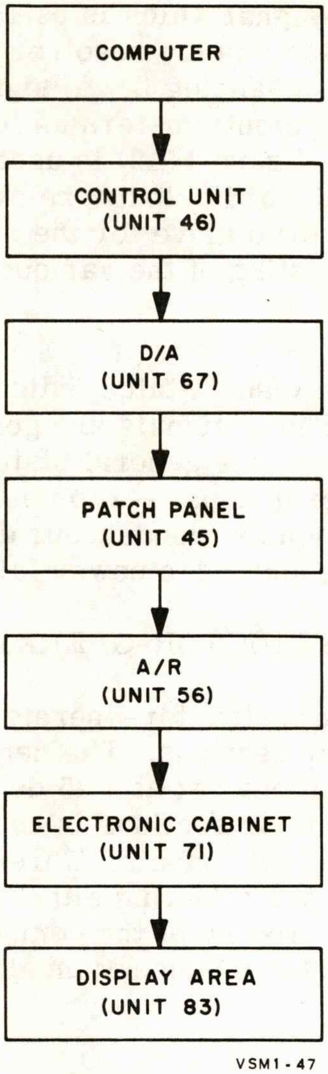


Figure 1-47. Typical D/AR Signal Flow

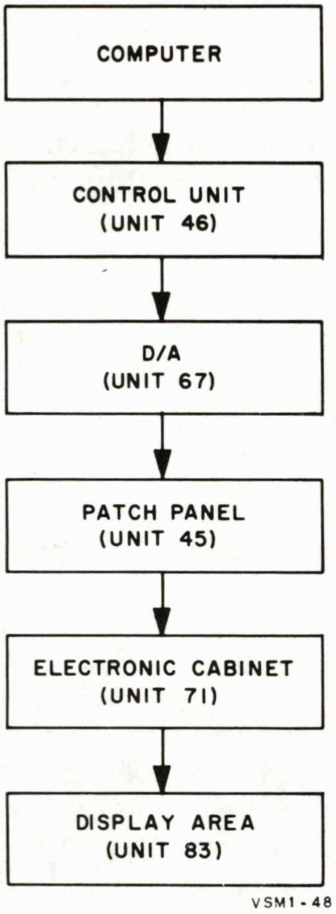


Figure 1-48. Typical D/A Signal Flow

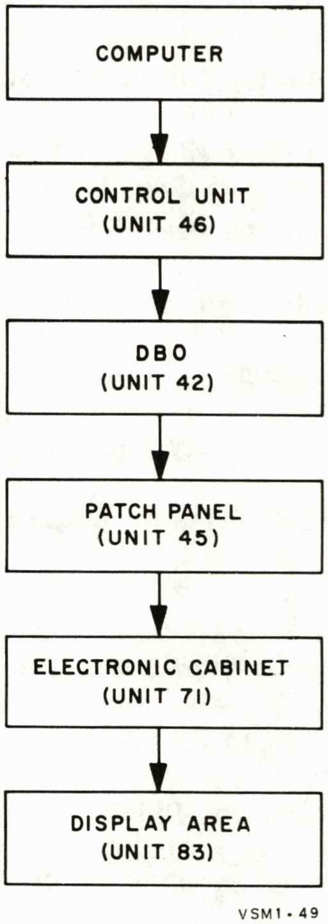


Figure 1-49. Typical DBO Signal Flow

Table 1-22. Digital Signals Required

Servo System	Quantity				
	D/R	D/AR	D/A	DBO	DWOR
Sextant and Telescope					
Starfield image "A" servo	1	1			
Starfield image "B" servo	1	1			
Landmark image "A" servo	1	1			
Landmark image "B" servo	1	1			
Landmark illumination intensity				3	
Telescope reticle servo		1			
Telescope occultation		3			
Sextant reticle servo	1				
Sextant variable magnification	1				
Starfield servo drive		1			
Slide selection					1
Sextant polaroid		1			
Starfield selection					1
Sextant sunshafting control				1	
Starfield off signal				1	
Sextant derotation prism		1			
Telescope sunshafting control				1	
Mission Effects Projectors					
Attitude pitch servo	1	9			
Attitude yaw servo	1	9			

Table 1-22. Digital Signals Required (Cont)

Servo System	Quantity				
	D/R	D/AR	D/A	DBO	DWOR
Attitude roll servo	1	9			
Orbital film drive (two cassettes)	10			4	
Transboundary film drive (one cassette)		5		2	
Translunar orbital drive	5			1	
Earth/Moon illumination varifocal drive			10	2	
Earth/moon Angenieux lens varifocal drive			10	2	
Iris diaphram drive			5		
Extended range off-course drive			5	1	
Day-night terminator time drive			5	1	
Day-night terminator angular position drive			5	1	
Orbital film off-course drive			10		
Transboundary varifocal illumination			5	1	
Transboundary cassette angular film drive			5		
Transboundary Angenieux varifocal drive			5	1	
Transboundary horizon mask varifocal drive			5	1	
Sunshafting scanning mirror pitch drive			4		

Table 1-22. Digital Signals Required (Cont)

Servo System	Quantity				
	D/R	D/AR	D/A	DBO	DWOR
Sunshafting scanning mirror yaw drive			4		
Sunshafting image focus drive			4		
Solar iris drive				5	
Quick dissolve				5	
Spherical distortion lens				1	
Earth blanking shutter				5	
Turret indexing drive				2	
Transboundary cassette drive		5		2	
Sunrise annuli drive				1	
Transboundary scene blanking				5	
Cassette selection				4	
Arc lamps				42	
Quick dissolve enabling				5	
Solar blanking shutter				4	
Starfield Display Unit					
Celestial sphere roll drive		5			
Celestial sphere pitch drive		5			
Celestial sphere yaw drive		5			
Earth/moon starfield occultation			5		
"X" drive					

Table 1-22. Digital Signals Required (Cont)

Servo System	Quantity				
	D/R	D/AR	D/A	DBO	DWOR
Earth/moon starfield "Y" drive			5		
Earth/moon starfield occultation "Z" drive			5	1	
LEM starfield occultation "X" drive			2		
LEM starfield occultation "Y" drive			2		
LEM starfield occultation "Z" drive			2	1	
Rendezvous and Docking Systems					
Camera position servo			1 (fast)		
Focus servo drive			1		
CRT translational drive			2		
Sun translational drive			1		
Vidicon Alpha drive			1 (fast)		
Vidicon Beta drive			1		
Sun rotational drive			2		
Model Eta drive			2		
Model Zeta drive			2		
Model Xi drive			2		

Table 1-22. Digital Signals Required (Cont)

Servo System	Quantity				
	D/R	D/AR	D/A	DBO	DWOR
CRT raster size servo			2		
Raster azimuth electronic drive			2 (fast)		
Raster elevation electronic drive			2 (fast)		
Video on-off				2	
Model to slide projector				1	
Sun illumination				1	
Earth illumination				1	
Simulator freeze				1	
Video level			2		

1-233. FUNCTIONAL DESCRIPTION.

1-234. The following descriptions of the visual components and subassemblies are for familiarization with the units that make up the AMS visual system. The descriptions are detailed to a degree that permits a thourough understanding of the system.

1-235. TELESCOPE AND SEXTANT.

1-236. The telescope and sextant simulate the operational hardware and provide an optical system which provides a means for combining various images.

1-237. The telescope optics also simulates occultation of its field of view as the line of sight of the telescope approaches the Astro door opening. The simulated sextant duplicates the actual sextant in operation and is slaved to the telescope position.

1-238. The following paragraphs present detailed functional descriptions of both the simulated telescope and sextant.

1-239. **TELESCOPE.** (See figure 1-50.) The telescope is, essentially, a system of fixed optical components. All of the components listed in table 1-1 down to and including the cube beamsplitter, which is the first element in the combined lines of sight, are enclosed within the cover panels of the telescope.

1-240. With the exception of the MEP, the celestial sphere, and the C/S illuminator and occulting assembly, the optical components were accurately positioned at the time of assembly and are not subject to operational movement.

1-241. Landmark and Starfield Scene Generation. As described in paragraphs 1-14 through 1-17 the generation of simulated earth/moon and starfield scenes in the optical paths of the telescope are functions of the MEP and the celestial sphere subsystems. A secondary function of these subsystems is the simulation of the command module's oscillation in roll, pitch, and yaw (within the 0.5 degree deadband of stabilization) during a navigational sighting.

NOTE

> More detailed functional descriptions of the landmark and starfield scene generation equipment is contained under the appropriate headings.

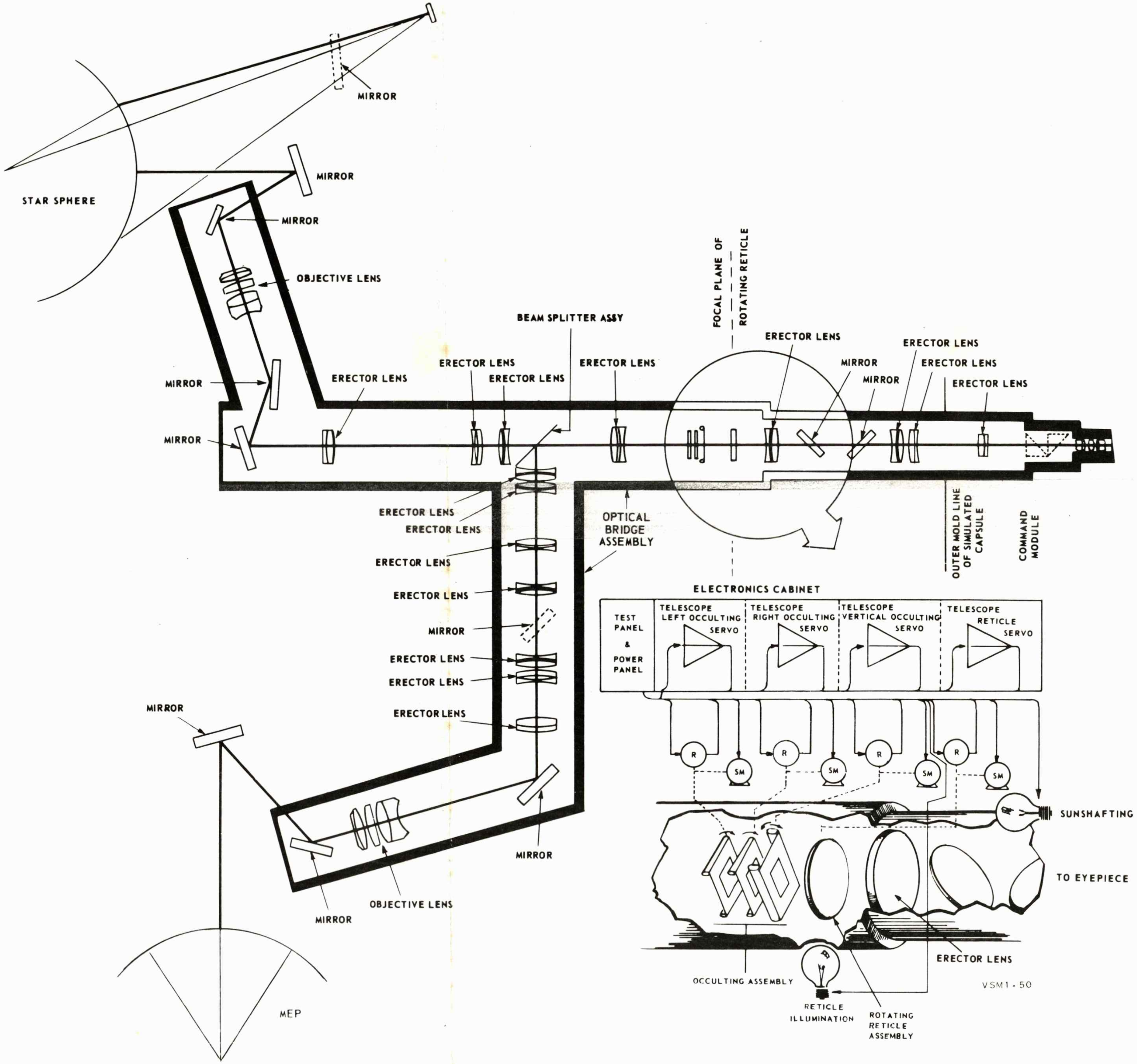


Figure 1-50. Telescope Functional Diagram

1-242. Telescope Internal Fixed Optics. The function of each optical assembly within the telescope enclosure, depending upon its type (lens assembly or mirror) and location, is to relay or reflect the landmark and starfield scenes along established optical paths. In the case of the cube beamsplitter, the two scenes are combined to produce concurrent images on the plane of the rotating reticle. The final relay lens prior to the reticle focal plane is a cell assembly, installed in the reticle, occulting and lens assembly, which is mounted on the face of the optical bridge outside the telescope's main enclosure.

1-243. With the exception of the MEP and the celestial sphere, the two operable components of the telescope are the command module occulting assembly and the rotating reticle assembly. These are contained in the cylindrical casting mounted on the vertical face of the optical bridge. The assembly, referred to in paragraph 1-242 as the reticle, occulting and lens assembly, must be removed as a unit in order to replace either of the operable units.

1-244. Command Module Occulting Assembly. A discussion of the functioning of the occulting unit requires a brief discussion of the functioning of the operational telescope in the Apollo navigational system for a complete understanding. The line of sight of the operational telescope is controllable in two axes. The shaft axis (or landmark-seeking line of sight) is perpendicular to the shell of the command module and can be rotated 360 degrees; the trunnion axis (or star-seeking line of sight) is capable of deviation from the shaft axis up to 62 degrees. The combination of the shaft axis rotation and the trunnion axis deviation thus provides control of the line of sight over a solid (conical) angle of 124 degrees for any one position of the command module with respect to a particular landmark. The operational telescope commands a 60 degree field of view, and extreme deviation of the line of sight (center of the field of view) provides a total visual display covering a solid angle of 184 degrees. Since the entrance aperture of the operational telescope is inside the shell of the command module, occultation will occur when the command module window interferes with the optical path. The amount of occultation that will be evidenced is a variable function of combined shaft axis rotation and trunnion axis deviation from the normal.

1-245. Occultation of the simulator telescope's field of view is accomplished by an electro-mechanical unit, schematically illustrated in figure 1-51. In operation, error signal commands from the simulator computers are transmitted to one or, as required, two of the resolvers via the electronics cabinet. Signals are then amplified to a-c driving voltages, imposed on the corresponding motor-generator servo which rotates the blade reel in the required direction. This rotation causes the opaque portion of the blade to move across the clear aperture in the line of sight until the desired amount of occultation is observed on the focal plane of the reticle.

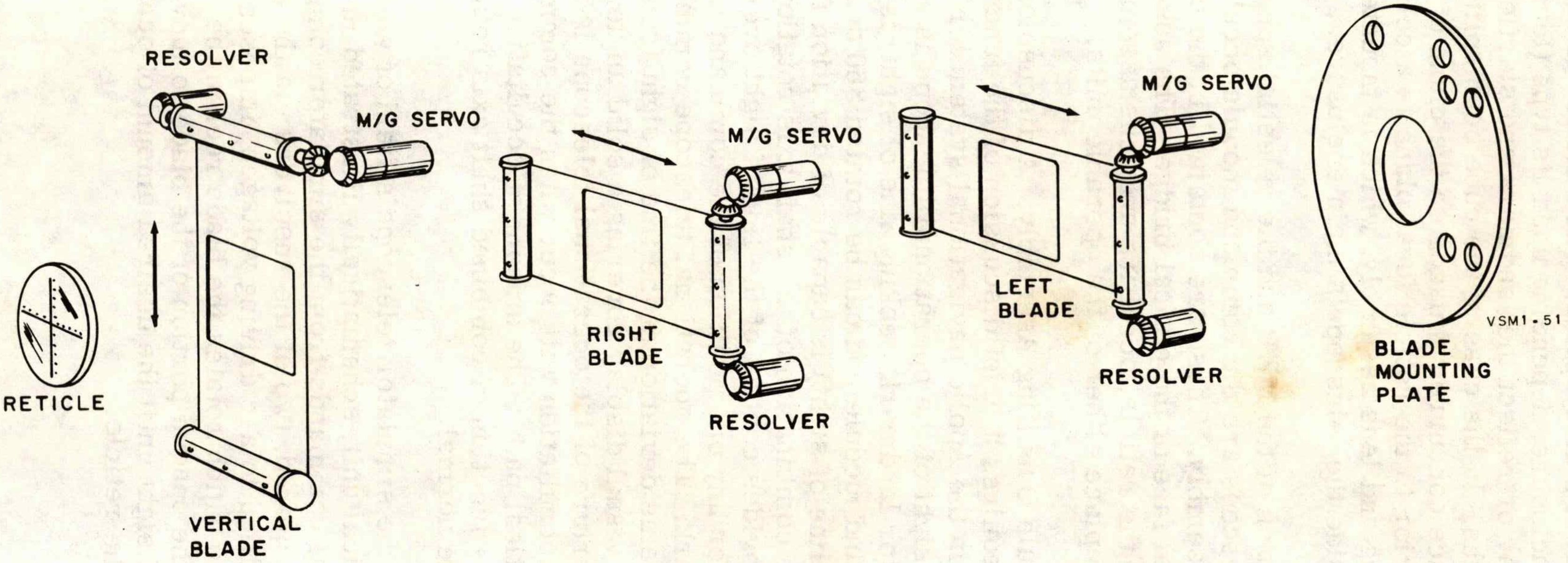


Figure 1-51. Occulting Unit Mechanical Schematic

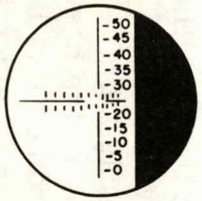
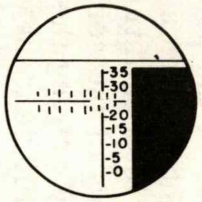
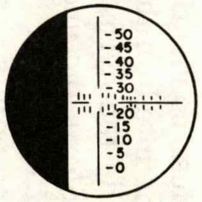
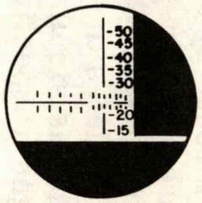
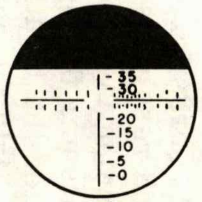
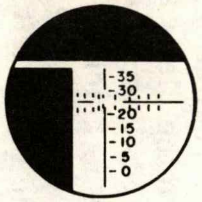
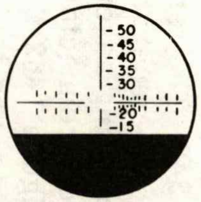
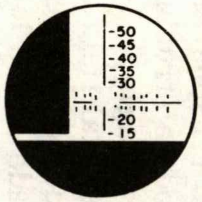
1-246. Simulated occulting of the telescope's field of view is required for two reasons. Partial occultation, interference by a portion of the command module structure with the clear aperture of the instrument, has been explained in paragraph 1-244 and illustrated in table 1-23. Complete occultation, wherein the total field of view is blacked-out, simulates the closing of the command module's navigation window covers. This is simulated by driving the right blade or the left blade to the left or right, respectively, 100 percent when a condition simulating 0 degrees shaft and trunnion axes rotation exists. When a condition exists that simulates some degree of shaft axis rotation, in conjunction with some degree of turnnion axis rotation, a lesser percentage of right and/or left blade drive, accompanied by a corresponding amount of vertical blade drive, will accomplish complete occultation simulation. Conversely, the opening of the navigation window covers is simulated by reversing the above procedure.

1-247. Partial occultation, resulting from combined shaft and trunnion axes rotation, is simulated as listed and illustrated in table 1-23. Although only eight conditions of occultation are listed, it is to be understood that intermediate conditions are possible and dependent on the electrical equivalents of resolver sine and cosine angle values transmitted by the simulator computers. Because optical inversion and reversion of the reticle image occurs in the optical path to the eyepiece, the movement of the occulting blades is referred to in the table as apparent; the actual blade movement is, in each instance, the reverse.

1-248. The terminal boards for electrical connections to the occulting unit's motor-generators and resolvers are mounted on the rear surface of the occulting assembly mounting plate inside the cylindrical casting. The leads from connector 13J1 enter through a hole in the underside of the casting. Figure 1-52 illustrated the locations of the terminal boards on the mounting plate, and table 1-24 lists the connection points to the several electrical components.

1-249. Rotating Reticle Assembly. The operational telescope is provided with two freedoms of movement: (1) 360 degrees of rotation around a shaft axis normal, or perpendicular, to the shell of the command module, and (2) rotation of star seeking optics about a trunnion axis that permits deviation of the star line of sight up to 62 degrees from the shaft axis. Thus, by combining shaft axis rotation and trunnion axis rotation (within the 62 degree limit of deviation from the shaft axis), navigational stars that lie within the area of the celestial sphere that is subtended by a conical (solid) angle of 124 degrees may be located for any one position of the command module. Figure 1-53 illustrates schematically the relationship between shaft axis and trunnion axis angles of rotation for locating navigational stars with the operational telescope.

Table 1-23. Typical Command Module Occultation

COMMAND MODULE SIMULATED OCCULTATION	APPARENT OCCULTING UNIT BLADE MOVEMENT	RESULTING OCCULTATION AS OBSERVED ON THE RETICLE	COMMAND MODULE SIMULATED OCCULTATION	APPARENT OCCULTING UNIT BLADE MOVEMENT	RESULTING OCCULTATION AS OBSERVED ON THE RETICLE
INTERFERENCE BY THE RIGHT EDGE OF THE WINDOW.	RIGHT BLADE APPEARS TO MOVE TO THE LEFT.		INTERFERENCE BY UPPER RIGHT CORNER.	RIGHT BLADE APPEARS TO MOVE TO THE LEFT AND VERTICAL BLADE APPEARS TO MOVE DOWNWARD.	
INTERFERENCE BY WINDOW CENTER PARTITION.	LEFT BLADE APPEARS TO MOVE TO THE RIGHT.		INTERFERENCE BY LOWER RIGHT CORNER.	RIGHT BLADE APPEARS TO MOVE TO THE LEFT AND VERTICAL BLADE APPEARS TO MOVE UPWARD.	
INTERFERENCE BY TOP EDGE OF THE WINDOW.	VERTICAL BLADE APPEARS TO MOVE DOWNWARD.		INTERFERENCE BY UPPER LEFT CORNER.	LEFT BLADE APPEARS TO MOVE TO THE RIGHT AND VERTICAL BLADE APPEARS TO MOVE DOWNWARD.	
INTERFERENCE BY LOWER EDGE OF THE WINDOW.	VERTICAL BLADE APPEARS TO MOVE UPWARD.		INTERFERENCE BY LOWER LEFT CORNER.	LEFT BLADE APPEARS TO MOVE TO THE RIGHT AND VERTICAL BLADE APPEARS TO MOVE UPWARD.	

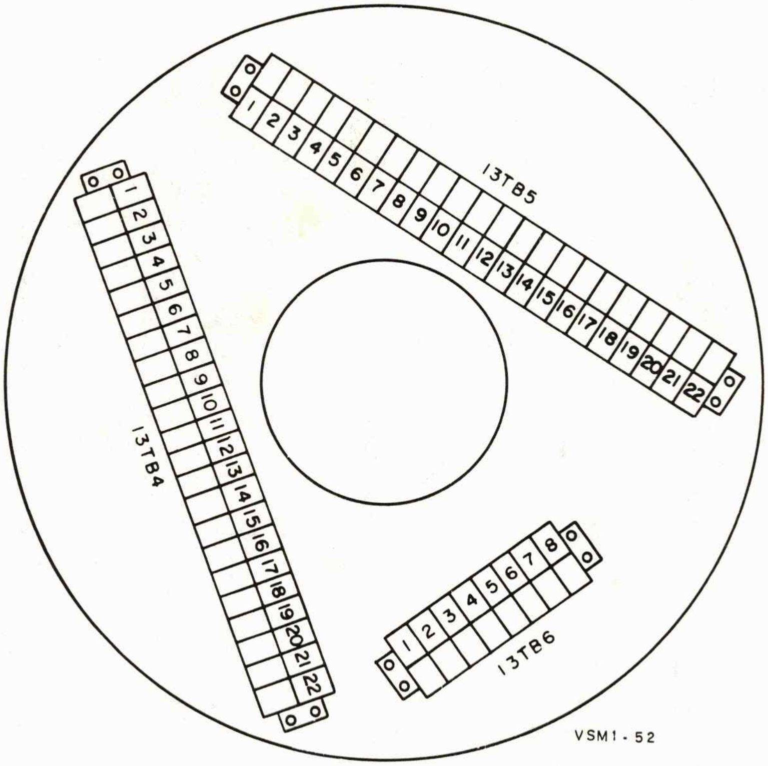


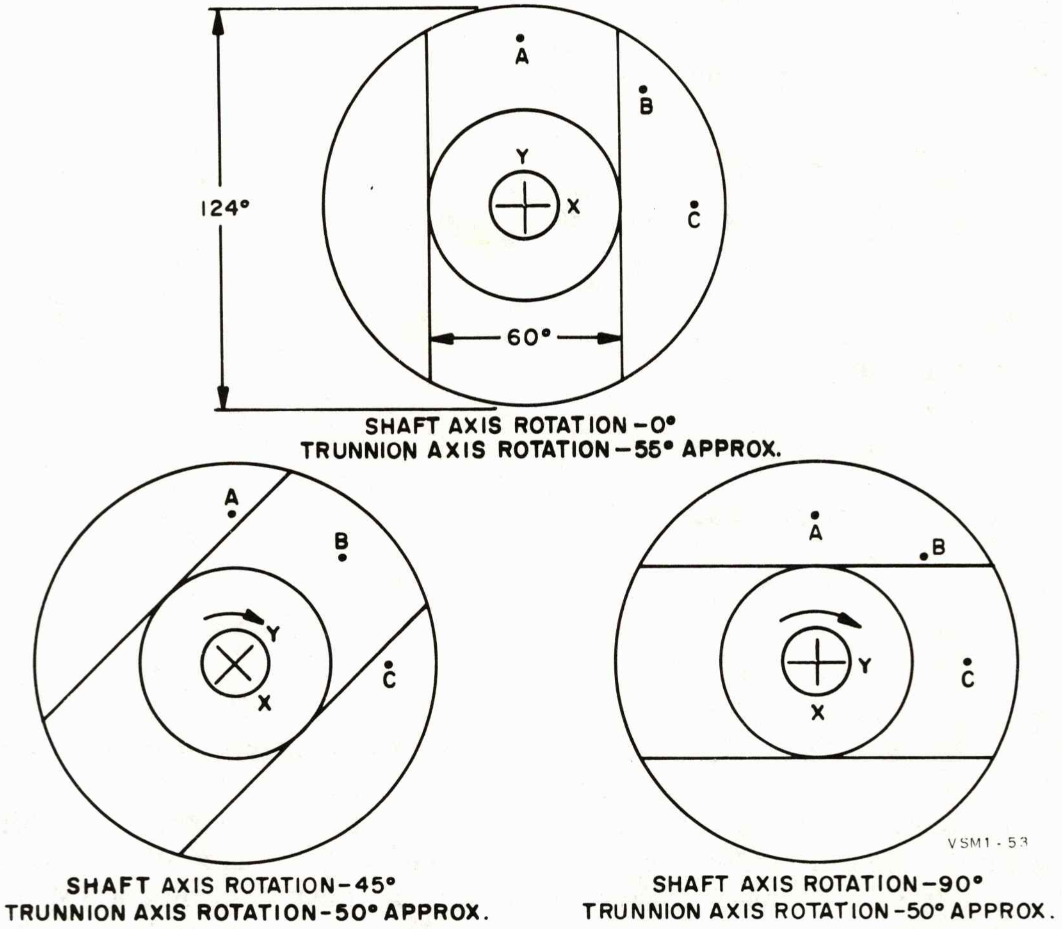
Figure 1-52. Occulting Unit Terminal Board Locations

1-250. In the AMS telescope, the trunnion axis rotation is simulated by rotation of the celestial sphere in pitch or yaw movements to bring the desired navigational star within the 60 degrees field of view of the telescope's star-field line of sight. Shaft axis rotation is simulated by celestial sphere rotation on the roll axis and corresponding reticle rotation. In the operational telescope, the reticle rotates with the shaft axis. The engraving of the rotating reticle duplicates the reticle engraving in the operational telescope, thus providing additional simulation of the images. The reticle is edge-lighted by four miniature lamps located at 90 degree intervals around the periphery.

1-251. The rotating reticle may be rotated through 360 degrees of continuous motion, or it may be positioned at any intermediate degree of rotation by the actuation of a single-speed a-c servo system. A computer generated error signal is transmitted to a "pancake" resolver in the reticle assembly via the test panel in the electronics cabinet. The returned error signal is rectified and amplified by a d-c amplifier and the resultant d-c power drives the rotor of a torque motor (to which the reticle is mechanically fastened) to the desired angular position. The resolver rotor turns with the motor rotor, and when the error signal is nulled, rotation ceases. The terminal boards for the rotating reticle electrical connections are mounted on the outer surface of the rotating reticle mounting plate, which also forms the cover plate of the

Table 1-24. Occulting Unit Electrical Wiring Data

Component	Long Cable No.	Connector No. & Pin Nos. on Tele.	Terminal Board No. & Connection Points
Occulting Right Blade			
Motor		13J1 - $\underline{v}$, $\underline{y}$	13TB4 - 9, 10, 13, 14, 15, 16
Tachometer		13J1 - $\underline{n}$, $\underline{p}$	13TB4 - 11, 12
Resolver Rotor	W542	13J1 - $\underline{e}$, $\underline{m}$	13TB6 - 1, 2
Resolver Stator		13J1 - O, V, W	13TB6 - 4, 5, 6
Occulting Left Blade			
Motor		13J1 - $\underline{w}$, $\underline{z}$	13TB4 - 1, 2, 5, 6, 7, 8
Tachometer		13J1 - $\underline{r}$, $\underline{s}$	13TB4 - 3, 4
Resolver Rotor	W542	13J1 - Z, $\underline{a}$	13TB5 - 1, 2
Resolver Stator		13J1 - U, $\underline{b}$, $\underline{c}$	13TB5 - 4, 5, 6
Occulting Vertical Blade			
Motor		13J1 - L, R	13TB5 - 15, 16, 17, 18, 21, 22
Tachometer		13J1 - F, G	13TB5 - 19, 20
Resolver Rotor	W542	13J1 - J, K	13TB5 - 8, 9
Resolver Stator		13J1 - A, B, D	13TB5 - 11, 12, 13



NOTE:
A, B, C INDICATE NAVIGATIONAL STARS.

Figure 1-53. Navigational Starseeking Schematic

reticle, occulting and lens assembly. The terminal boards are designated 13TB2 and 13TB3, respectively. Data regarding the electrical connections is listed in table 1-25.

1-252. Fixed Optics Between Reticle Assembly and Eyepiece.
The fixed optical elements (see figure 1-3) between the reticle, up to and including the telescope eyepiece, are contained in two major subassemblies:

a. Lens and mirror housing assembly, consisting of:

  1. Cell assembly

  2. Mirror

3. Mirror
4. Sunshafting lamp assembly
5. Cell assembly

b. Tube and mounting plate assembly, consisting of:

1. Cell assembly
2. Cell assembly
3. Prism housing assembly
4. Eyepiece housing assembly

The principal function of the above assemblies is to relay the combined starfield and landmark images, as focused on the plane of the reticle, to the eye of the astronaut in the command module. The deflection of the image forming light, beaming downward 32.5 degrees from the horizontal, is achieved by the angular placement of the mirrors in the lens and mirror housing assembly. The sunshafting lamp, mounted in this assembly, is controlled by an ON/OFF signal from the computers and simulates the reflection of the sun's rays in the optical system of the operational telescope when the line of sight approaches the sun. The purpose of the sunshafting simulation is to train the astronaut to re-orient his instrument to avoid sun-blinding. Cell assemblies are adjusted in the tube and mounting plate assembly to provide the fixed minus one diopter eyepiece focus. In addition, the mounting plate, prism housing, and removable eyepiece assemblies, shown in figure 1-3 are designed and fabricated to provide the astronaut with the exact visual simulation of what he will see while in the Apollo command module.

1-253. SEXTANT. The operational sextant in the Apollo Command Module is used in conjunction with the operational telescope to take celestial navigational sightings at specified times during the trans-lunar and trans-earth trajectory phases of the Apollo mission. The angular readouts between pre-selected navigational stars and pre-selected landmarks (on earth or the moon) provide course and velocity correctional data for the G&N subsystem. The function of the simulator sextant in the AMS visual system is to present realistic simulations of what the astronaut will see through the eyepiece of the operational sextant, and thus provide training in the use of the navigational instruments.

Table 1-25. Rotating Reticle and Sunshafting Wiring Data

Component	Long Cable No.	Connector No. & Pin Nos. on Tele.	Terminal Board No. & Connection Points
Rotating Reticle			
Motor	W543	13J2 - D, E	13TB3 - 2, 3
Resolver Rotor	W543	13J2 - $\underline{w}$, $\underline{x}$	13TB2 - 1, 2
Resolver Stator	W543	13J2 - $\underline{j}$, $\underline{k}$, $\underline{l}$	13TB2 - 3, 4, 5
Edge Lights	W542	13J1 - H, P	13TB3 - 4, 5, 6, 7, 8, 9, 10, 11
Sunshafting Lamp	W542	13J1 - N, T	13TB2 - 7, 8

1-254. The individual functions of each component of the sextant, both fixed optics and opto-electro-mechanical subassemblies, is described in the paragraphs to follow, Figure 1-54 graphically illustrates the physical location of each of the sextant's components. Details concerning the single-speed and two-speed servo systems, and the associated electronics, are contained in paragraphs covering the AMS telescope/sextant electronics cabinet (unit No.9).

1-255. Combined Light Sources, Landmark And Starfield. Two 150-watt lamps, each providing a light source for one of the optical paths, are housed in one assembly. Each of the lamps, along with a "cold" mirror and an exhaust cooling fan, are separately enclosed in individual compartments within the assembly. During the normal (simulated mission) mode of operation, the lamps are turned on and off by computer signals. In the test mode of operation, the landmark light source lamp is controlled by a toggle switch installed in the lamp compartment, and the starfield lamp is controlled by a rheostat on the power control panel in the electronics cabinet. A reusable, 20-micron mesh, stainless steel wire screen filter is installed in the cooling air inlet for each compartment.

1-256. Landmark Line Of Sight. The landmark line of sight, as can be seen from the block diagram (see figure 1-54), is composed of various assemblies and subassemblies. These assemblies, subassemblies, and the components which make up the landmark line of sight, are discussed separately in the following paragraphs.

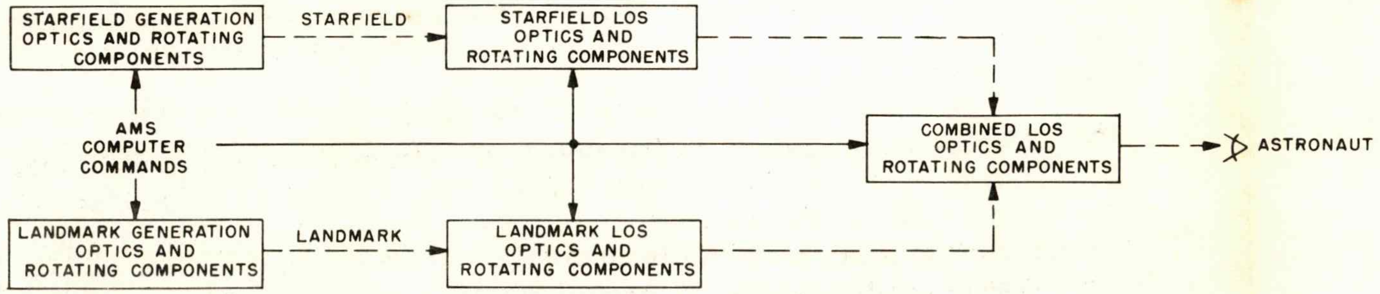
1-257. The carousel assembly, including the slide actuator subassembly consists of:

a. A servo motor-generator and resolver for rotation drive.

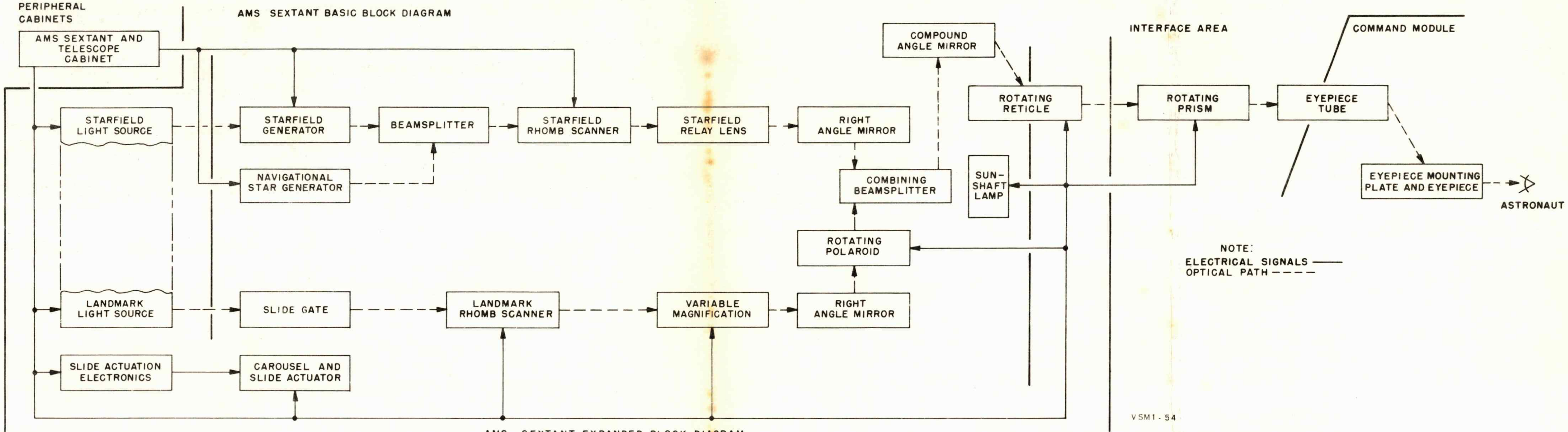
b. An enclosed gear train, running in an oil bath, that provides a speed reduction ratio of450:1 between the driving motor and the magazine-supporting center post bull gear.

c. A replaceable magazine from which 90 slide frames are suspended in channel section supports on the underside of the magazine's circular plate. The slide supports radiate from the center of the plate and are equi-spaced. Two lifting handles are provided for removal of the magazine from the carousel center post. A guide pin, projecting from the top of the center post, enters a corresponding hole in the magazine plate insuring correct positioning. Three socket head cap screws secure the magazine to the post.

d. A slide actuator subassembly, incorporating its own Sloysn motor drive, uses an indexing cam and linkage arrangement to drive a hooked rod to retract and inject slides between the slide gate on the sextant optical bed and the carousel magazine. The slide actuator also incorporates both electrical and mechanical interlocks that prevent operation of the carousel rotation drive



AMS SEXTANT BASIC BLOCK DIAGRAM



AMS SEXTANT EXPANDED BLOCK DIAGRAM

Figure 1-54. Sextant Flow Block Diagrams

unless all 90 slide frames are completely stowed in the magazine. The entire carousel is supported on an extension portion of the sextant's supporting frame, and is enclosed in a light and dust tight cover; a separate circular cover is provided for removal of the magazine for maintenance or replacement purposes. Removal of the magazine cover actuates a switch that electrically disables both the carousel and the slide actuator.

1-258. The 90 slide frames in the magazine are aluminum fabrications, approximately 5-1/4 inches square. Each frame holds an octagonal glass plate to which one of the 89 landmark scenes is cemented. The scenes (earth or moon, refer to tables 1-26 and 1-27) are enlargements of the central 2.2 degree portion of the landmark scenes projected on the MEP screen of the AMS telescope. The 28-power magnification of the operational sextant is simulated in the AMS sextant by means of the scene enlargement. The reason for enlarging the central 2.2 degree portion of the MEP scene is that the simulator's computers are programmed to command the presentation of a slide in the landmark line of sight only when the shaft axis of the telescope (to which the shaft axis of the sextant is slaved) is centered on the central 2.2 degree area of the MEP scene. The 90th slide frame in the carousel magazine carries a test pattern (see figure 2-64). A functional description of the test pattern and its use, in relationship to the engraving on the rotating reticle (see figure 2-65) is contained in paragraphs 2-58 through 2-65.

Table 1-26. Lunar Landmarks

Landmark	Longitude	Latitude
Magelhaens	44° 57' 24"	-12° 40' 52"
Vitrovius	33° 47' 47"	17° 46' 28"
Dawes	26° 19' 37"	17° 13' 03"
Arago	21° 22' 57"	6° 10' 31"
Dionysius	17° 16' 31"	2° 48' 04"
Sulticuius	11° 39' 06"	19° 35' 26"
Pickering	7° 00' 09"	- 2° 50' 10"
Conon	1° 57' 48"	21° 37' 56"
Bode	357° 34' 57"	6° 44' 36"
Lassell	352° 08' 45"	-15° 26' 24"
Gambart C	348° 13' 37"	3° 20' 46"
Gambart	344° 48' 12"	0° 57' 00"
Gay-Lussac A	339° 41' 31"	13° 10' 39"
Hortensius	332° 05' 08"	6° 28' 13"
Gassendi A	320° 18' 08"	-15° 31' 19"
Flamsteed	315° 41' 39"	- 4° 29' 38"

Table 1-27. Earth Landmarks

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
1	Cape Receife, south of Port Elizabeth in Algoa Bay	Union of South Africa	S 34° 02'	E 25° 42'
2	Cape St. Francis, located southwest of Port Elizabeth in St. Francis Bay	Union of South Africa	S 34° 12'	E 24° 50'
3	Cape Agulhas, which is the southernmost tip of South Africa	Union of South Africa	S 34° 50'	E 20° 01'
4	Cape of Good Hope	Union of South Africa	S 34° 41'	E 18° 30'
5	The Northernmost tip of coast in St. Helena Bay at a town called "Stompneusbaai"	Union of South Africa	S 32° 42'	E 17° 58'
6	The tip of the southern bank at the mouth of the Orange River	Union of South Africa	S 28° 38'	E 16° 27'
7	Northern tip of the peninsula at the city of Durban	Union of South Africa	S 29° 52'	E 31° 03'
8	Southern tip of the peninsula at the town of Richards Bay	Union of South Africa	S 28° 48'	E 32° 05'
9	Westernmost peninsula located in Luderitz Bay	Southwest Africa	S 26° 38'	E 15° 05'
10	"Pelican Point" in Walvis Bay	Southwest Africa	S 22° 53'	E 14° 26'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
11	Dam near the town of Kariba connecting Lake Kaiba and the Zambezi River	Northern Rhodesia	S 16° 32'	E 28° 46'
12	The Western tip of Kilwa Island located in Lake Mweru	Northern Rhodesia	S 09° 15'	E 28° 29'
13	Southern tip of the island called "Nosy Magabe" located in the northern part of the bay called "Baie Antongil"	Malagasy Republic	S 15° 31'	E 49° 40'
14	Southern tip of the island called "Ile Sainte-Marie" at the town of Talavia	Malagasy Republic	S 17° 07'	E 49° 49'
15	Point called "Pointe Fenambosy" located on the spit of land enclosing the Bay called "Baie De Fenambosy"	Malagasy Republic	S 25° 15'	E 44° 21'
16	Northern tip of the Peninsula called "Cape Lopez". It is located in the bay called "Baie Du Cap Lopez"	Gabon (French Colonial Territory (French Equatorial Africa)	S 00° 37'	E 8° 43'
17	Extreme tip of a sand bar beyond the city of Mayoumba	Gabon (French Colonial Territory (French Equatorial Africa)	S 3° 23'	E 10° 40'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
18	Northern tip of the shoreline in the estuary called "Estuaire Du Gabon"	Gabon (French Colonial Territory (French Equatorial Africa)	N 00° 21'	E 9° 21'
19	Tip of the peninsula in the harbor of Pointe Noire	French Congo	S 4° 49'	E 11° 54'
20	Westernmost tip of the peninsula about three statute miles northwest of the city of Dakar	Senecal (French Colonial Territory) (French West Africa)	N 14° 39'	N 17° 26'
21	Southeastern tip of the island of "Anjouan"	Comoro Islands	S 12° 22'	E 44° 30'
22	A portion of the two mile wide crater "Karthala"	Comoro Islands	S 11° 45'	E 43° 22'
23	Dam at the north end of a lake called "Lake Kolwezi"	Republic of the Congo	S 10° 30'	E 25° 28'
24	Junction of Lake Mweru and the Luvua River at the town of Preto	Republic of the Congo	S 8° 29'	E 28° 53'
25	Airport at Leopoldville called "N' Duili" (runway 5400 ft)	Republic of the Congo	S 4° 23'	E 15° 26'
26	Northern tip of the peninsula in Lake Tanganyika about two statute miles north of the town of Manga	Republic of the Congo	S 4° 03'	E 29° 14'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
27	Junction where the Ruzizi River flows into Lake Tanganyika	Republic of the Congo	S 3° 21'	E 29° 12'
28	Southern tip of the peninsula called "Cap Blanc"	Mauritania	N 20° 46'	W 17° 03'
29	Fuawi Point on the west coast of Lake Nyasa	Rhodosia & Myasaland	S 12° 56'	E 34° 19'
30	Western tip of Boadzula Island in the southern part of Lake Nyasa	Rhosodia & Myasaland	S 14° 16'	E 35° 08'
31	A point at the junction of the Benue and Niger Rivers at the town of Lokoja	Nigeria (British Territorial Colonies)	N 7° 49'	E 6° 46'
32	Western tip of Sherbro Island at the town of Kambia	Bierra Leone	N 7° 34'	W 12° 57'
33	Northwesternmost tip of the coastline about three statute miles west of Freetown	Bierra Leone	N 8° 30'	W 13° 17'
34	Highest point on Mt. Cameroons	British Cameroons	N 4° 12'	E 9° 10'
35	Northernmost shoreline of the largest island in the middle of Lake Zuai	Ethiopia	N 7° 57'	E 38° 52'
36	A point on the junction of the Blue Nile and Dadesa Rivers	Ethiopia	N 10° 05'	E 35° 40'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
37	Any point on the shoreline of the island called Daga in the lake called "T'Ana"	Ethiopia	N 11° 53'	E 37° 18'
38	A point at the city of Bathurst	Gambia	N 13° 27'	W 16° 35'
39	Southern tip of the westernmost island in the group of islands called "Iles De Los". Island is about six statute miles west of Conakry	Guinea	N 9° 27'	W 13° 50'
40	Southern tip of a sand bar called "Ponta Da Macaneta"	Portuguese Territorial Colonies Mozambique	S 25° 52'	E 32° 45'
41	Southern tip of the peninsula jutting into the bay called "Baia De Inhambane"	Portuguese Territorial Colonies Mozambique	S 23° 44'	E 35° 25'
42	Northern tip of the island called "Ilha Do Bazaruto"	Portuguese Territorial Colonies Mozambique	S 21° 31'	E 35° 29'
43	Shoreline at the mouth the river "Rio Pungue" near the town of Beira	Portuguese Territorial Colonies Mozambique	S 19° 51'	E 34° 50'
44	Highest point (9760 ft) on the island of Fogo	Cape Verde Islands	N 14° 57'	W 24° 21'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
45	Northern tip of a large spit of land called "Punta Da Marca"	Angola	S 16° 31'	E 11° 42'
46	Tip of the sand bar in the Harbor of Luanda	Angola	S 8° 51'	E 13° 14'
47	Northern tip of a peninsula jutting into the mouth of the Congo River. The peninsula is located at the town of Santa Antonio Da Zaire	Angola	S 6° 4'	E 12° 20'
48	Island at the junction of the Blue Nile and White Nile located at the city of Omdurman	Sudan	N 15° 37'	E 32° 30'
49	LM is either the southern tip of the peninsula across Rusinga Channel at the mouth of the Kavirondo Gulf	Kenya	S 00° 24'	E 34° 17'
50	Northern tip of South Island located in Lake Rudolf	Kenya	N 2° 38'	E 36° 37'
51	Northernmost shoreline of North Island in Lake Rudolf	Kenya	N 4° 05'	E 36° 02'
52	Cape Rhir on the coast of Morocco	Morocco	N 30° 37'	W 9° 54'
53	Western tip of Goba Island in Lake Tanganyika	Republic of Zanzibar and Tanganyika	S 6° 58'	E 29° 50'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
54	Eastern tip of Ukerewe Island opposite the town of Rugezi. Ukerewe Island is located in Lake Victoria	Republic of Zanzibar and Tanganyika	S 2° 06'	E 33° 12'
55	Northern tip of Mafia Island about 7.5 statute miles north of the town of Kanga	Republic of Zanzibar and Tanganyika	S 7° 38'	E 39° 55'
56	Northern tip of Zanzibar Island at the town of Mwanda	Republic of Zanzibar and Tanganyika	S 05° 44'	E 39° 18'
57	Northern tip of Pemba Island about 3.5 statute miles north of the town of Mideran	Republic of Zanzibar and Tanganyika	S 04° 53'	E 39° 41'
58	Southernmost tip of the island of "La Palma" at the point called "Punta De La Fuencaliente"	Canary Islands (Spain)	N 28° 27'	W 17° 50'
59	Westernmost tip of the island of "Tererife" about 2.5 statute miles west of the town called "Buenavista"	Canary Islands (Spain)	N 28° 20'	W 16° 55'
60	Easternmost tip of the island of "Tenerife" about two statute miles north of the town of "Igueste"	Canary Islands (Spain)	N 28° 35'	W 16° 07'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
61	Northernmost tip of the island of Gran Canaria at the port of the city of "Las Palmas"	Canary Islands (Spain)	N 28° 11'	W 15° 24'
62	Southwesternmost tip of the island called "Isla De Fuerteventura" at the point called "Punta De Jandia"	Canary Islands (Spain)	N 28° 04'	W 14° 30'
63	LM is southern tip of the peninsula called "Peninsula De Yala" at the point called "Punta Dunford"	Spanish Sahara	N 23° 40'	W 16° 02'
64	LM is northwestern tip of a compound spit at a point called "Punta Carducci". The spit is called "Penisoka Di Hafun"	Somali Republic	N 10° 33'	E 51° 10'
65	"Cabo De Vola" on a peninsula called "De Guajira" in northern Columbia	Columbia	N 12° 13'	W 72° 10'
66	Southwestern tip of an island called "Isla De Baru". It is one of the group of islands called "Islas De El Rosario"	Columbia	N 10° 13'	W 75° 42'
67	Cape called "Cabo Corrientes" located in the Gulf of Panama	Columbia	N 5° 29'	W 77° 33'
68	Southern tip of a cape called "Cabo Marzo" located in the Gulf of Panama	Columbia	N 6° 51'	W 77° 42'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
69	Northern tip of peninsula called "Punta San Francisco Solano" located in the gulf called "Golfo De Cupica" and in the Gulf of Panama	Columbia	N 6° 17'	W 77° 28'
70	El Dorado Airport (12,400 ft.) located northwest of Bogota	Columbia	N 4° 42'	W 74° 08'
71	Tumaco Airport (runway 12,000 ft.) located in the bay called "Rado De Tumaco"	Columbia	N 1° 50'	W 78° 45'
72	The island south of the island called "Isla Gorgona" off the western coast of Columbia	Columbia	N 2° 56'	W 78° 13'
73	Large bridge near the city of Maracaibo where the lake called "Maracaibo" flows into the gulf called "Venezuela"	Venezuela		
74	Airport called "Naiquetia" (7200 ft.) located near Caracas	Venezuela	N 10° 37'	W 66° 58'
75	Cape called "Cabo Cadera" east of the city of Caracas	Venezuela	N 10° 35'	W 66° 03'
76	Man made structure on the southwest bank of a large lake near the town of Calabozo	Venezuela	N 8° 57'	W 67° 24'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
77	Eastern tip of an island called "Enterprise" at the mouth of the Essequibo River	British Guiana	N 6° 57'	W 58° 20'
78	Esmeraldas Airport (20,000 ft.) located at the mouth of the river called "Rio De Esmeraldas"	Ecuador	N 0° 58'	W 79° 37'
79	Airport (7300 ft.) called "General Ulpiano Paez" located on the peninsula called "La Puntilla"	Ecuador	S 2° 13'	W 80° 58'
80	Town opposite the airport called "Los Pepales" at the entrance to the bay called "Bahia De Caraquez"	Ecuador	S 0° 36'	W 80° 31'
81	Tip of coast called "Ponta Da Baleia" northeast of the town of Armacao	Brazil	S 17° 42'	W 39° 08'
82	Southeastern tip of "Ilha De Sao Sebastiao	Brazil	S 23° 58'	W 45° 15'
83	Small island called "Cabo Frio" east of a large sand bar and about 80 statute miles due east of Rio De Janeiro	Brazil	S 23° 00'	W 41° 59'
84	Point of land on the southern bank of the mouth of the Paraiba River at the town of Atafona	Brazil	S 21° 37'	W 41° 01'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
85	Point of land at the mouth of a river near the town of "Espirito Santo De Vitoria"	Brazil	S 20° 19'	W 40°' 16'
86	Mouth of the canal "De Sao Goncato" east of the city of Pelotas	Brazil	S 31° 47'	W 52° 14'
87	Augusto Servero Airport (7400 ft. runway) south of Natal on eastern coast of Brazil	Brazil	S 5° 44'	W 35° 15'
88	Tip of the peninsula at the town of Cabedelo	Brazil	S 6° 58'	W 34° 50'
89	Guarapes Airport (runway 6200 ft.) near the city of Recife	Brazil	S 8° 08'	W 34° 57'
90	"Ponta Manguinho" located at the mouth of the San Francisco River	Brazil	S 10° 31'	W 36° 24'
91	Southern tip of Salvador City located in the bay called "Bahia De Todos Os Santos"	Brazil	S 13° 01'	W 38° 33'
92	"Cabo Orange" in the mouth of the "Rio Uaca" in Brazil	Brazil	N 4° 24'	W 51° 33'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
93	Julio Cesar Airport (runway 6500 ft.) near the city of Belem in the bay called "Baia De Marajo"	Brazil	S 1° 22'	W 48° 29'
94	Tirirical Airport (runway 5700 ft.) on the island called "Ilha Do Maranhao" in the bay called "Baia De Sao Marcos"	Brazil	S 2° 38'	W 44° 17'
95	Tip of "Ponta Do Muciripe" near Fortaleza on northeastern coast of Brazil	Brazil	S 3° 42'	W 38° 28'
96	"Punta Das Desertes" located in the northern section of the lake "Dos Patos"	Brazil	S 30° 26'	W 50° 54'
97	Western edge of sand bar where a railroad bridge crosses the lagoon called "Lagoa Imarui"	Brazil	S 28° 26'	W 48° 50'
98	Southern tip of a sand bar on the eastern side of the lagoon called "Lagoa Dos Patos" located south of the town "Pontal Da Barra" at a breakwater	Brazil	S 32° 09'	W 52° 04'
99	Tip of coastline jutting into the bay "Bahia De Sechuro" and called "Punta Aguja"	Peru	S 5° 47'	W 81° 04'
100	Tip of coast called "Punta Parinas" near the town of Negritos which is located south of a large oilfield	Peru	S 4° 40'	W 81° 20'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
101	"Punta Lachay" near the town of "Las Salinas"	Peru	S 11° 18'	W 77° 39'
102	Trujillo Airport (runway 5900 ft.) located west of Trujillo.	Peru	S 08° 06'	W 79° 07'
103	Southern tip of the peninsula in the bay "Bahia De Samanco"	Peru	S 9° 14'	W 78° 34'
104	Tip of the peninsula jutting out from the city of Lima off the island of San Lorenzo	Peru	S 12° 04'	W 77° 10'
105	Island called "Isla San Gallan" west of the peninsula Paracas	Peru	S 13° 50'	W 76° 27'
106	Located on the south shore of San Juan Bay	Peru	S 12° 22'	W 75° 12'
107	"Punta Tinaja" located on the coast near the Pan American Highway	Peru	S 16° 15'	W 73° 43'
108	"Punta Coles" near Ilo Airport and south of the town of Ilo	Peru	S 17° 43'	W 71° 23'
109	"Isla De Panza" in the lake called "Lago De Poopo" located on the northwestern tip of the island	Bolivia	S 18° 32'	W 67° 12'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
110	Northern tip of the peninsula in lake "Titicaca" opposite the island called "Isla De Titicaca"	Bolivia	S 16° 03'	W 69° 08'
111	Southern tip of "Punta Del Este" located south of San Carlos and about 85 statute miles due east of Montevideo	Uruguay	S 34° 58'	W 54° 57'
112	Jet Airport east of Montevideo	Uruguay	S 34° 50'	W 56° 03'
113	Southern tip of peninsula jutting out from San Diego Harbor	United States	N 32° 39'	W 117° 14'
114	Northern tip of Santa Catalina Island	United States	N 33° 28'	W 118° 36'
115	Fork in Colorado River at Parker Dam where the Colorado branches into Williams River	United States	N 34° 18'	W 114° 08'
116	Where runway meets with tip of peninsula south of Port Royal off the coast of South Carolina	United States	N 32° 18'	W 80° 40'
117	Tip of an off-shore bar called "Cape Lookout" off the coast of North Carolina	United States	N 34° 35'	W 76° 32'
118	Southern tip of "Cape Fear" a cuspate delta in the mouth of "Cape Fear" River near Wilmington, North Carolina	United States	N 33° 51'	W 77° 58'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
119	Airport (Scholes Field) on Galveston Island in Gulf of Mexico off the coast of Texas	United States	N 29° 16'	W 94° 51'
120	Airport (Tyndall, 10,000 ft) on the coast near Panama City, Florida	United States	N 30° 04.5'	W 85° 34.5'
121	McKinnon Airport (6,000 ft) near Brunswick on coast of Florida	United States	N 31° 09'	W 81° 24'
122	Airport (Mayport 6,000 ft) near Jacksonville Beach on coast of Florida	United States	N 30° 24'	W 81° 25'
123	Airport on Florida coast near New Smyrna Beach	United States	N 29° 4'	W 80° 57.5'
124	Patrick Air Force Base near Cape Kennedy, Florida	United States	N 28° 15'	W 80° 36.5'
125	Tip of point jutting into bay near Corpus Christi, Texas	United States	N 27° 41'	W 97° 14.5'
126	Eastern tip of seven mile causeway connecting Marathon Island with Big Pine off the southern tip of Florida	United States	N 24° 42.5'	W 81° 07'
127	Westernmost tip of Key West Island	United States	N 24° 32.5'	W 81° 48'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
128	Southern tip of break in off-shore bar at Biscayne Bay off east coast of Florida, approximately seven miles south of Miami Beach	United States	N 25° 40'	W 80° 09'
129	Southern tip of five mile causeway connecting St. Petersburg with Bradenton	United States	N 27° 35.5'	W 82° 38'
130	Tip of Cabo Haro (South tip) near Guaymas in Gulf of California	Mexico	N 27° 50'	W 110° 53'
131	Tip of Punta Palsa off Lower California in North Pacific Ocean	Mexico	N 27° 51'	W 115° 05'
132	Tip of Punta Abreojos off Lower California in North Pacific Ocean	Mexico	N 26° 43'	W 113° 37'
133	Punta Tosca, southern tip of Isla Magdalena off Lower California in North Pacific Ocean	Mexico	N 24° 19'	W 111° 42'
134	Tip of peninsula in Bahia De La Paz near La Paz	Mexico	N 24° 11'	W 110° 19.5'
135	Main dam on Lago Toronto	Mexico	N 27° 33'	W 105° 25'
136	Tip of Cabo San Lucas, at head of Lower California	Mexico	N 22° 52'	W 109° 54'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
137	Southern tip of Mazatlan on western coast of Mexico	Mexico	N 23° 11'	W 106° 25'
138	Lighthouse at Cabo Corrientes on western coast of Mexico	Mexico	N 20° 25'	W 106° 42.5'
139	Mouth of Rio Panuco near Tampico on eastern coast of Mexico	Mexico	N 22° 16'	W 97° 48'
140	Merida Airport (7000 ft runway) near Merida in Yucatan, Mexico	Mexico	N 20° 56'	W 89° 40'
141	Cozumel Airport (7000 ft runway) on Isla De Cozumel off the coast of Yucatan, Mexico	Mexico	N 20° 32'	W 86° 56'
142	Central Airport (9800 ft runway) near Mexico City, Mexico	Mexico	N 19° 27'	W 99° 5'
143	Carmen Airport on Isla De Carmen in Golfo De Campeche off east coast of Mexico	Mexico	N 18° 39'	W 91° 48'
144	Point of land jutting into the Pacific Ocean called "Cabo Santa Elena"	Landmarks for Costa Rica	N 10° 54'	W 85° 58'
145	Peninsula off western coast of Costa Rica at point called "Cabo Bianco"	Landmarks for Costa Rica	N 9° 34'	W 85° 7'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
146	Tip of peninsula in bay called "Bahia Charco Azul". The point of peninsula at the LM is called "Punta Burica"	Panama	N 8° 02'	W 82° 52'
147	Spit of land in Balboa Harbor in Panama City	Panama	N 8° 39'	W 79° 41'
148	Eastern tip of the island "Isla Coiba" called "Punta Anegada" which is located off the western coast of the peninsula "De Azuero"	Panama	N 7° 20'	W 81° 36'
149	Tip of Cabo De Tres Puntas in Gulf of Honduras	Landmarks for Guatemala	N 15° 57'	W 88° 37'
150	Point where Pan American Highway crosses river connecting Lago De Managua with Lago de Nicaragua	Landmarks for Nicaragua	N 12° 12'	W 86° 06'
151	Puerto Cabezas Airport (runway 6500 ft) on eastern Nicaraguan coast	Landmarks for Nicaragua	N 14° 03'	W 83° 24'
152	The 5,106 feet high peak of Volcan Ometepe on Isla De Ometepe. The island is located in the lake called "Lago de Nicaragua"	Landmarks for Nicaragua	N 11° 32'	W 85° 39'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
153	Western tip of Grand Bahama Island at the West End Settlement	Bahama Islands (UK)	N 26° 37'	W 79° 00'
154	Simms Point on New Providence Island	Bahama Islands (UK)	N 25° 02'	W 77° 35'
155	Powell Point on Eleuthera Island about 6 statute miles northwest of Free Town	Bahama Islands (UK)	N 24° 52'	W 76° 20'
156	Northern tip of Eleuthera Island about 5 statute miles northwest of Gregory Town opposite Northern Eleuthera Island	Bahama Islands (UK)	N 25° 26'	W 76° 36'
157	Southern tip of Long Island at a point called Cape Verde	Bahama Islands (UK)	N 22° 51'	W 74° 51'
158	Columbus Point at the southern tip of Cat Island	Bahama Islands (UK)	N 24° 08'	W 75° 16'
159	The southern tip of Castle Island about 4 statute miles south of Acklins Island	Bahama Islands (UK)	N 22° 07'	W 74° 20'
160	The "Southwest Point" of Mayaguana Island	Bahama Islands (UK)	N 22° 22'	W 73° 11'
161	LM is "Northwest Point" on "Great Inagua Island"	Bahama Islands (UK)	N 21° 07'	W 73° 40'
162	Point on the southern tip of Grand Turk Island	West Indies (UK)	N 21° 26'	W 71° 19'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
163	Western tip of the sand bar outside the city of Kingston in Jamaica	West Indies (UK)	N 17° 56'	W 76° 51'
164	"South Negril Point" on the western tip of Jamaica Island	West Indies (UK)	N 18° 16'	W 78° 22'
165	Westernmost tip of Anguilla Island	West Indies (UK)	N 18° 10'	W 63° 11'
166	Highest point (3596 ft) on Nevis Island	West Indies (UK)	N 17° 09'	W 62° 34'
167	Northeastern tip of Trinidad at Galera Point	West Indies (UK)	N 10° 50'	W 60° 54'
168	Galeota Point on the southeastern extremity of Trinidad Island about 3.5 statute miles southeast of the town of Guayaguayere	West Indies (UK)	N 10° 08'	W 60° 59'
169	Any feature on Grand Cayman Island such as Conch Point	West Indies (UK)	N 19° 23'	W 81° 22'
170	Point in the mouth of Guantanamo Bay	Cuba	N 19° 54'	W 75° 10'
171	The western tip of "Ile de la Tortue" called "Pointe Ouest"	Haiti	N 20° 04'	W 72° 59'
172	"Cabo Falso" in the bay called "Bahia de las Aguilas" on the island of Hispaniola	Dominican Republic	N 17° 46'	W 71° 42'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
173	Point on the tip of land called "Cabro Cabron" in the Dominican Republic	Hispaniola	N 19° 21'	W 69° 12'
174	The southwestern tip of Puerto Rico at a point called "Cabo Rojo"	Puerto Rico	N 17° 56'	W 67° 12'
175	Westernmost tip of Puerto Rico at the point called "Punta Higuero"	Puerto Rico	N 18° 22'	N 67° 16'
176	Spanish Fortress in the harbor of San Juan	Puerto Rico	N 18° 28'	W 66° 07'
177	Eastern tip of Grande-Terre Island at the point called "Pointe des Chateaux"	Guadaloupe (France)	N 16° 15'	W 61° 11'
178	Tip of the peninsula on the eastern coast of Martinique about 6.5 statute miles east of the town of "La Trinite"	Windward Islands (France)	N 14° 46'	W 60° 53'
179	On Hawaii Island at a point called "Ka Heiauo Kalalea" (South Cape)	Hawaii (U.S.A.)	N 18° 55'	W 155° 41'
180	Eastern tip of Hawaii Island at a point called "Cape Kumukahi"	Hawaii (U.S.A.)	N 19° 31'	W 154° 49'
181	"Kaena Point" on the western tip of Oahu Island	Hawaii (U.S.A.)	N 21° 34'	W 158° 17'
182	"Cape Halawa" on the eastern tip of Molakai Island	Hawaii (U.S.A.)	N 21° 9'	W 156° 43'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
183	Northernmost tip of Kangaroo Island at "Point Marsden" which is about 60 nautical miles southwest of the city of Adelaide	Australia	S 35° 34'	E 137° 38'
184	Southwestern tip of Yorke Peninsula at "Corny Point"	Australia	S 34° 54'	E 137° 00'
185	Southwestern tip of Coffin Bay Peninsula at "Point Widbey"	Australia	S 34° 35'	E 135° 06'
186	Southwestern tip of Kangaroo Island at "Cape Du Conedle"	Australia	S 36° 04'	E 136° 41'
187	Northern tip of Wardang Island at "Island Point"	Australia	S 34° 27'	E 137° 22'
188	Port at Port Augusta	Australia	S 32° 29'	E 137° 40'
189	"Sugarloaf Point", approximately 110 nautical miles northeast of Sidney	Australia	S 32° 28'	E 152° 31'
190	Point at the city of Sidney such as Port Jackson or Cape Banks	Australia	S 33° 51'	E 151° 17'
191	Southernmost tip of "Cape Arid" which is southeast of Tagon Harbour and southwest of Sandy Bight	Australia	S 34° 02'	E 123° 09'
192	"Cape Le Grand" southeast of Esperance Bay and southwest of Mississippi Bay	Australia	S 34° 00'	E 122° 05'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
193	Point at the city of Albany in King George Sound	Australia	S 35° 02'	E 117° 55'
194	"Cape Naturaliste" located in Geographe Bay	Australia	S 33° 32'	E 115° 00'
195	Cape at Flinders Bay	Australia	S 34° 23'	E 115° 08'
196	Mouth of Swan River at the city of Perth	Australia	S 32° 03'	E 115° 44'
197	Northern tip of lagoon at a town called "Ballina"	Australia	S 28° 51'	E 153° 35'
198	"Cape Peron" at the northern tip of Peron Peninsula which is located midway between Dirk Hartog Island and the mainland	Australia	S 25° 32'	E 113° 29'
199	Southern tip of Dorre Island at a point called "Cape St. Cricq"	Australia	S 25° 18'	E 113° 05'
200	"Point Lookout" which is the northeastern tip of North Stradbroke Island	Australia	S 27° 25'	E 153° 33'
201	"Cape Moreton" which is the northeastern tip of Moreton Island	Australia	S 27° 02'	E 153° 28'
202	"Double Island Point" located at Wide Bay	Australia	S 25° 56'	E 153° 11'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
203	"Sandy Cape" located at the northern tip of Fraser Island	Australia	S 24° 42'	E 153° 16'
204	Easternmost point at the tip of "North West Cape"	Australia	S 21° 49'	E 114° 11'
205	Northwestern tip of Legendre Island	Australia	S 20° 21'	E 116° 50'
206	Pasco Island located off the southern tip of Barrow Island	Australia	S 20° 58'	E 115° 21'
207	Northern tip of "South Island" which is one of the Percy Islands	Australia	S 21° 43'	E 150° 21'
208	"Gantheaume Point" just north of Roobuck Bay	Australia	S 17° 59'	E 122° 10'
209	"Cape Bowling Green" in the northern tip of a sandbar	Australia	S 19° 19'	E 147° 25'
210	Eastern tip of "Great Palm Island" one of the Palm Islands off the eastern coast of Australia	Australia	S 18° 46'	E 146° 42'
211	"Cape Ford" located southwest of Anson Bay	Australia	S 13° 26'	E 129° 53'
212	"Cape Hay" located southwest of Hyland Bay	Australia	S 14° 03'	E 129° 28'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
223	Southeast tip of Lake Anak Meer about 2 nautical miles west of the crater of an active volcano called "Goenoeng Rindjani" on Lomrh Island	Indonesia	S 18° 25'	E 116° 25'
224	"Tandjoeng Gede" (Java Head) at the western tip of Java	Indonesia	S 6° 45'	E 105° 12'
225	"Balimbing" at the southern tip of Sumatra and the western tip of a peninsula forming Semangko Bay with the mainland	Indonesia	S 5° 55'	E 104° 33'
226	The mile long breakwater (about 1/4 miles from shore) at the harbor of Djakarta near the town of Tandjoengpriok	Indonesia	S 6° 06'	E 106° 52'
227	"Taboetoele Island" of southwest Celebes in the strait called "Salajak"	Indonesia	S 5° 39'	E 120° 26'
228	Southern tip of Salajak Island south of southwest Celebes	Indonesia	S 6° 30'	E 120° 29'
229	"Tandjoeng (Cape) Berikat" on the east tip of Bangka Island in the South China Sea	Indonesia	S 2° 34'	E 106° 50'
230	"Tandjoeng (Cape) Djang" on the east tip of Poelau (Island) Lingga	Indonesia	S 0° 18'	E 105° 00'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
213	Point at the city of Darwin	Australia	S 12° 28'	E 130° 51'
214	Southwest tip of Maria Island which is located in Limmen Bight	Australia	S 14° 55'	E 135° 41'
215	Southern tip of "Duifken Point on the western coast of Cape Yorke Peninsula	Australia	S 12° 33'	E 141° 39'
216	"Cape Direction" located east of Lloyd Bay	Australia	S 12° 51'	E 143° 32'
217	"Cullen Point" at a bay called Port Musgrave on the west coast of Cape Yorke Peninsula	Australia	S 11° 58'	E 141° 55'
218	"Cape Croker" on the northern tip of Croker Island	Australia	S 10° 57'	E 132° 36'
219	"Northeast Point" on Christmas Island	Australia	S 10° 24'	E 105° 45'
220	"Tandjoang Poerwa" at the western tip of the island called "Shiereiland Poerwa"	Indonesia	S 8° 45'	E 114° 21'
221	Northern tip of a peninsula called "Tandjoang Somboeloengan" north of Schiereiland Poerwa	Indonesia	S 8° 27'	E 114° 24'
222	LM is "Tandjoeng Sasar" a peninsula on the northernmost point of Soemba (Sumba) Island	Indonesia	S 9° 15'	E 119° 56'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
231	"Tandjoeng Karang" in northern Celebes	Indonesia	S 0° 38'	E 119° 45'
232	"Kaap (Cape) William" on the west coast of Celebes at a bay called "Mamoedguebaai"	Indonesia	S 2° 37'	E 118° 48'
233	"Hoek (Cape) Van Mandar" in western Celebes	Indonesia	S 3° 34'	E 118° 56'
234	Town of Pepedi on a peninsula off north Celebes Island	Indonesia	S 00° 01'	E 119° 40'
235	"Tandjung Sial" on the southwestern tip of Seram (Ceram) Island	Indonesia	S 3° 33'	E 127° 55'
236	"Udjung (Point) Batu Mamak" south of the "Teluk (Inlet) Tapanuli"	Indonesia	N 1° 33'	E 98° 43'
237	The isthmus where Pulau Island in Lake Danan Toba joins the mainland of central Sumatra	Indonesia	N 2° 36'	E 98° 41'
238	The vicinity of the city of Singapore	Indonesia	N 1° 15'	E 103° 49'
239	"Tanjong (Cape) Datu" at the northwest tip of Borneo at the border between Indonesia and northwest Sarawak	Indonesia	N 2° 05'	E 109° 38'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
240	The northern tip of "Pulau Lembek"" Island off northeast coast of Celebus (Sulawesi)	Indonesia	N 1° 33'	E 125° 17'
241	"Tanjong Bisoa" at the northern tip of Halmakera Island, one of the Molucca Islands	Indonesia	N 2° 13'	E 127° 57'
242	Eastern tip of Halmakera Island at a point called "Tanjong Ngolopopo"	Indonesia	N 0° 12'	E 128° 54'
243	"Tanjong Sempang Mangayau" north of the town of Keretan in North Borneo	Sarawak and Northern Borneo (Federation of Malasia)	N 7° 3'	E 116° 45'
244	"Tanjong Baram" south of the mouth of the Batang Baram River in Sarawak	Sarawak and Northern Borneo (Federation of Malasia)	N 4° 35'	E 113° 58'
245	The northeast tip of Ko Yai Island in the lagoon called "Lake Luang" at the point where the island is nearest the sand bar	Sarawak and Northern Borneo (Federation of Malasia)	N 7° 35'	E 100° 18'
246	Poelau Jaco, a small island at the eastern tip of Timor Island	Portuguese Timor	S 8° 26'	E 127° 19'
247	Town of Oisina at the southwest tip of Timor Island	Portuguese Timor	S 10° 21'	E 123° 26'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
248	Southeast tip of "Poelau (Island) Adi" off New Guinea	New Guinea and Vicinity	S 4° 19'	E 133° 36'
249	Single island in Lake Wisdom which is located in Long Island	New Guinea and Vicinity	S 5° 19'	E 147° 05'
250	"Tandjoeng Fatagar" on the western tip of "Schiereiland (Peninsula) Onin" located on Schiereiland Bomberai	New Guinea and Vicinity	S 2° 46'	E 131° 57'
251	"Tandjoeng Woka" on the western tip of Japan Island north of Geelvink Bay	New Guinea and Vicinity	S 1° 36'	E 135° 25'
252	"Tandjoeng Menori" northwest of Geelvink Bay	New Guinea and Vicinity	S 0° 51'	E 134° 08'
253	Southern tip of "Cape San Agustin" on southeastern Mindanao Island	Philippines	N 6° 15'	E 126° 11'
254	Highest point (2895 feet) on Balut Island one of the Sarangani Islands	Philippines	N 5° 24'	E 125° 22'
255	"Pucio Point" the southwest tip of a peninsula on Panay Island located at the western end of Ranlan Bay and near the town of Santander	Philippines	N 11° 46'	E 121° 50'
256	"Stangley Point" in Manila Bay on Luzon Island	Philippines	N 14° 30'	E 120° 54'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
257	"Cape San Ildefonso" on the southern tip of San Ildefonso Peninsula of the east coast of Luzon Island	Philippines	N 16° 02'	E 121° 59'
258	"Taguntun Point" at the southern tip of Cantanduanes Island	Philippines	N 13° 13'	E 124° 12'
259	"Cape Zelee" at the southern tip of Maramasika Island	Southwest Pacific	S 9° 48'	E 161° 33'
260	Cape St. George at the south tip of New Ireland Island	Southwest Pacific	S 4° 54'	E 152° 53'
261	Northern tip of a peninsula in Lake Dakataua near the northern coast of New Britain Island	Southwest Pacific	S 5° 00'	E 150° 06'
262	Motupena Point off the western coast of Bouganville Island	Southwest Pacific	S 6° 31'	E 155° 10'
263	Cape Cumberland at the northern tip of Espiritu Island	Southwest Pacific	S 14° 37'	E 166° 37'
264	"North Point" on Aurora Island	Southwest Pacific	S 14° 55'	E 168° 06'
265	"Cap Lefevre" on the western tip of "Ile Lifou"	Southwest Pacific	S 20° 55'	E 167° 02'
266	"Cap Ouabao" at the southwestern tip of Ile Maré	Southwest Pacific	S 21° 40'	E 167° 50'

Table 1-27. Earth Landmarks (Cont)

Earth Landmark Number	Landmark Name	General Location	Latitude	Longitude
267	Northwest tip of "Ile (Island) de Phu Zuoc" in the Gulf of Siam	Vietnam	N 10° 22'	E 103° 51'
268	"Cap (Cape) Saint Jacques" off the southeast coast of Vietnam and 40 nautical miles southeast of Saigon	Vietnam	N 10° 19'	E 107° 05'
269	Southern tip of a peninsula south of the town of "Ba Gia" located east of Honlon Island	Vietnam	N 12° 34'	E 109° 26'
270	Town of Konrei at the northern tip of Babelthuap Island, one of the Palau Islands	Northwest Pacific	N 7° 43'	E 134° 37'
271	Southwestern tip of Yap Island, one of the Caroline Islands	Northwest Pacific	N 9° 20'	E 138° 04'
272	Tip of the breakwater in Apra Harbor, on Guam	Northwest Pacific	N 13° 27'	E 144° 37'
273	Northern tip of Aruba Island at the town of Kudarebe	Netherlands Antilles	N 12° 37'	W 70° 04'

1-259. The normal condition of the sextant has a landmark slide in the slide gate on the optical bed. The slide will usually be the last slide used in the immediately preceding navigational sighting; the test pattern slide is only used during functional testing. Upon receipt of a command signal from the computers, via the electronics cabinet, for the presentation of another slide, the following sequence of events occurs:

a. The slide actuating assembly is energized and the slide in the slide gate is completely retracted into the carousel magazine.

b. The carousel rotation motor-generator obeys an error signal impressed on its resolver which is, in turn, amplified in the electronics cabinet. The carousel rotates the required number of degrees to bring the desired slide into alignment with the slide gate, at which point the error is nulled and rotation ceases.

c. The slide actuating assembly is again energized to inject the new landmark slide into the slide gate.

During the above described change of landmark slides, the landmark light source lamp is automatically switch off and on, so that the landmark line of sight is illuminated only when there is a slide in the gate. The carousel gearing, servo-drive, and slide actuation are designed to retract the slide in the gate, rotate the magazine, and insert another slide (no more than four slide positions away from the original slide) within one second of time. An interval of 3 seconds is permissible for a slide change involving 180 degree rotating of the slide magazine.

1-260. The landmark slide gate is the first mechanical assembly in the landmark line of sight mounted on the optical bed plate. Camrolls, mounted both vertically and horizontally along the groove provided for the landmark slide, help reduce friction and also accurately position the landmark scene in the calculated object plane of the landmark optical path. Two spring-loaded camrolls bear against the upper edge of the slide frame, which is chamfered at each end. It is the pressure of the outboard camroll against the rear chamfer that provides the final increment of travel, approximately 1/16 inch, that positions the slide so that the center of the landmark scene is within 0.0003 inch of the axis of the landmark optical path.

1-261. The landmark rhomb scanner is the first opto-electro-mechanical assembly in the landmark line of sight. The two rhomboid prims, mounted in series, can be rotated independently and in conjunction with each other. The line of sight, as seen on the reticle through the sextant eyepiece, may be displaced without loss of parallelism with what may be referred to as zero shaft axis deflection. This parallel displacement of the optical path permits the observer to view any portion of the landmark scene in the smaller field of view that is seen on the reticle through the sextant eyepiece.

1-262. Physically, the rhomb scanner consists of a large parallel mirror rhomboid and a smaller prims rhomboid, each mounted on a separate shaft. The shafts are driven through a sector gear and pinion arrangement by a two-speed servo system. As noted above, the two rhomboids are mounted in series, with the large mirror rhomb located first in the optical path. The mirror rhomboid, referred to as the landmark scanner, has a rotation range of plus or minus 15 degrees from its mechanical 0 position; the prism rhomboid, referred to as the landmark scanner, can be rotated plus or minus 30 degrees from its mechanical 0 position. The two-speed (1X and 32X) servo drives are provided so that very fine positioning of the two rhomboids is possible, as well as to overcome the inertias set up by the rotation of relatively heavy components. When both rhomboids are zeroed, the displacement of the optical path through the two rhombs is such that the landmark line of sight is apparently coincident with the shaft axis of the sextant.

1-263. The necessity for the landmark rhomb scanner in the simulated sextant may be explained as follows. (The following also applies to the starfield rhomb scanner with relation to viewing the simulated star groups surrounding the navigational stars. Refer to paragraph 1-28, listing the optical characteristics of the sextant.) The diameter of the landmark scene is 4.45 inches (star group diameter, 3.15 inches) which represents a solid (conical) angle of 4 degrees at the minimum magnification of 1/2 (the 3.15 inch diameter of the star group represents the same conical angle of a degrees at 1:1 magnification, provided in the starfield line of sight). The true field of view (FOV) of the sextant, as observed at the eyepiece, is a conical angle of 1.8 degrees, therefore, only a portion of the entire landmark scene will be seen on the reticle at any one time. In order to move, or scan, the FOV to all portions of the landmark scene, as might occur in the simulation of final command module stabilization for navigational sighting purposes, the optical path is displaced by the rotation of one or both rhomboids. (Figure 1-55 illustrates a simplified way in which the 1.8 degree FOV can be displaced by rotation of the rhomboids to permit viewing different portions of the 4 degree scene being presented. The large circle represents the 4.45 inch diameter landmark scene when viewed at minimum magnification, while the small circles represent the sextant's FOV looking at 4 different portions of the scene. Point "A" represents the center of the sextant's reticle directly in line with the center of the landmark scene and the surrounding circle represents the portion of the scene visible on the reticle as viewed through the eyepiece. This condition is obtained when both rhomboid prisms are mechanically zeroed, that is, at the midpoints of their respective rotations. Correspondingly, the three circles surrounding points "B", "C", and "D" represent different portions of the scene, as observed on the reticle, when the rhomboids have been rotated in response to command signals from the simulator computers.

1-264. In the condition described above, the illusion created would be that of the sextant's shaft axis line of sight moving over a relatively fixed scene until the condition illustrated by the fixation of "A" on the center of the landmark scene has been achieved. A related function of the rhomb scanners in

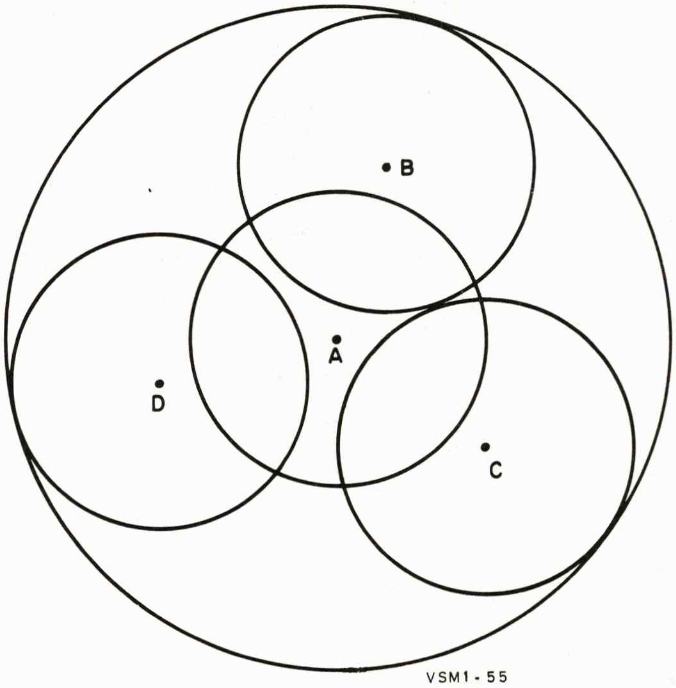


Figure 1-55. Rhomb Scanning Schematic

the sextant is to simulate the 0.5 degree roll, pitch, and yaw motions of the command module in the deadband of stabilization during a navigational sighting. This simulation is essentially the same as the one previously described and is achieved in exactly the same manner by individual or combined rotations of the rhomboids in response to computer generated command signals. The center of the line of sight, which is the center of the reticle, will appear to move away from the center of the landmark scene but only to the extent represented by 0.5 degree in any one direction.

1-265. Following the landmark rhomb scanner in the landmark optical path is an opto-electro-mechanical assembly called the variable magnification assembly. Physically, the assembly consists of symmetrical halves of a lens element, each half mounted in its own carrier or cell. The two lens carriers are suspended from a rigidly supported horizontal guide bar. By means of a lead screw and ball-nut mechanism driven by a single-speed a-c servo system, it can be driven back and forth along the landmark optical path through a total travel of approximately 8.8 inches. The two lens carriers can be separated and brought close together during the course of longitudinal travel. This is accomplished by a spring-loaded bell crank, one end of which is connected to the smaller of the two carriers and the other end terminating in a camroll that bears against a fixed, concave cam plate. At the two ends of travel, the lens halves are close together while at midpoint of travel the rotation of the bell-crank, caused by the camroll maintaining contact with the cam, moves the smaller lens carrier away from the larger until the two halves of the lens are most widely separated. The mechanical movement of the lens halves, and the resulting optical effect, are illustrated schematically in figure 1-56.

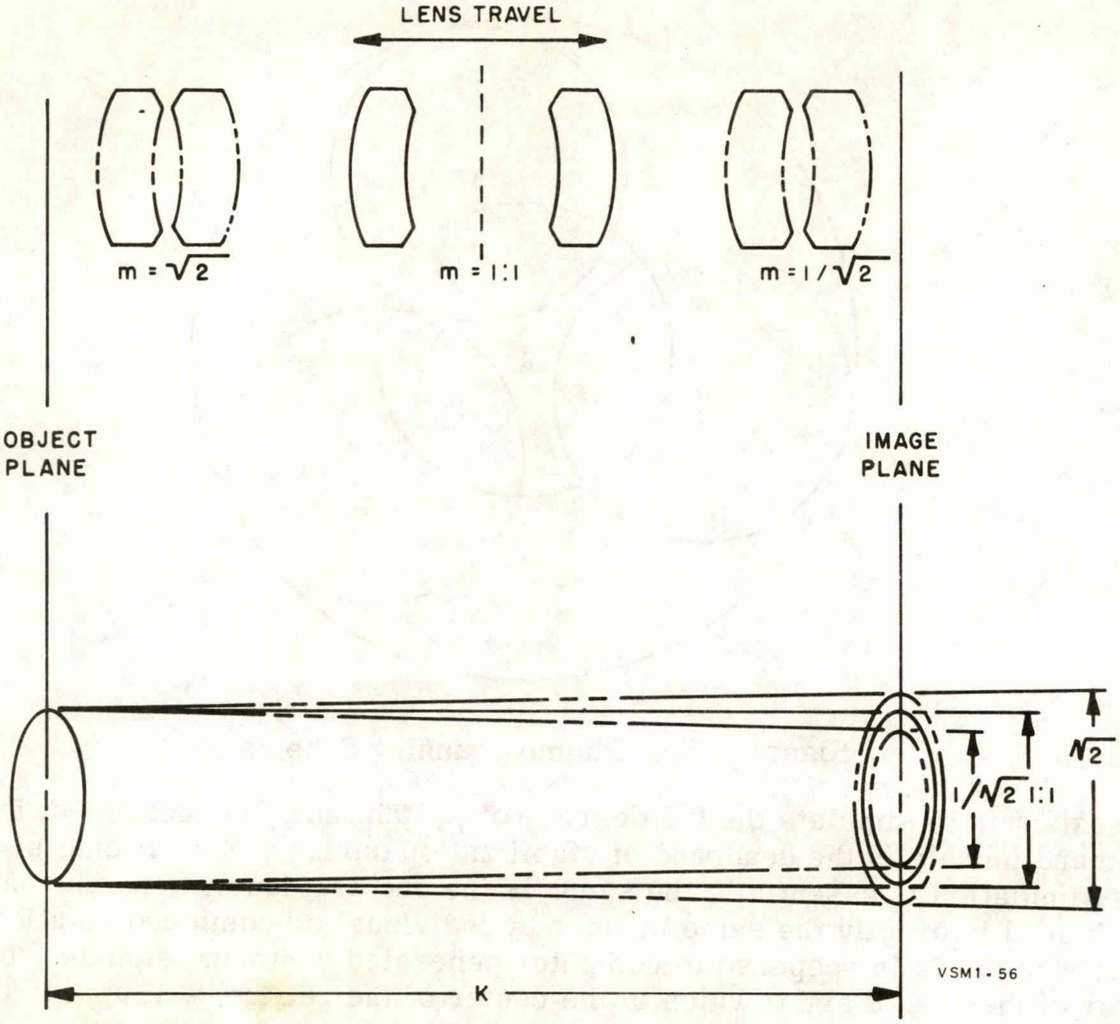


Figure 1-56. Variable Magnification Schematic

1-266. The desired optical effect is to provide a range of magnification of 2:1 for the landmark image while maintaining a constant distance between the object plane and the image plane. The actual degree of magnification or reduction is a maximum magnification of $\sqrt{2}$ when the lens halves are close together and nearest the object plane (landmark slide). A maximum reduction of $1/\sqrt{2}$ is when the lens halves are again close together and nearest the image plane (sextant reticle). When the carriage assembly is at the point of travel that produces the greatest separation of the lens halves, the relationship between object and image is 1:1.

1-267. The reason for the necessity of variable magnification in the landmark line of sight, as opposted to a fixed unity (1:1) magnification in the starfield line of sight, is apparent. During navigational sightings aboard the operational spacecraft, and consequently in the simulator, the landmark scene will increase or decrease in size,depending upon whether the spacecraft is approaching or

receding from the landmark. The degree of increase or decrease will be determined by the distance between the spacecraft and the landmark; i.e., the position of the spacecraft along its trajectory. However, because the astronomical distances to the navigational stars and the surrounding stars visible in the field of view are so great, they will appear as point source of light. There will, therefore, be no apparent change in the size or pattern of the individual star groups regardless of where the sighting is taken between the earth and the moon.

1-268. The landmark line of sight is deflected 90 degrees, in a plane parallel to the optical bed plate, toward the rotating polaroid filter assembly by the landmark right angle mirror.

1-269. The function of the rotating polaroid in the landmark LOS is to simulate the change in brightness of the landmark image on the reticle as the sextant's starfield and navigational star generation simulates the trunnion and shaft axes rotation of the operational sextant. Depending upon the relative positions of the landmark, sun, and the required navigational star, the landmark image on the reticle may be either brightened or darkened.

NOTE

> The operational sextant contains a polaroid filter that is attached to and rotates about the shaft axis with the array of mirrors that comprise the starfield line of sight.

A manually rotated polaroid analyzer in the sextant's eyepiece provides a means for adjusting the brightness of the landmark image, to that the superimposition of the navigational star on the landmark may be clearly distinguishable as viewed on the reticle. The rotating polaroid is the final operable component in the landmark line of sight and is driven by a single-speed d-c servo system.

1-270. Starfield Line Of Sight. The starfield line of sight is a combination of two optical legs which combine to form one optical leg of the sextant system. The various optical, electrical, and mechanical assemblies and components which make up the starfield line of sight are discussed in the following paragraphs.

1-271. The generation of the celestial scene presented in the starfield line of sight is accomplished by the starfield generator, the navigational star generating system, and the starfield beamsplitter. The illumination of the star groups, formed by the selective rotations of the starfield mask and starfield plate (components of the starfield generator), has been described in paragraph 1-255. The navigational star is formed by a separate light source and an optical system of lenses, prisms, density filters, and light tubing. As described in table 1-7, some of the navigational star generating system

components are in the starfield generator, and the balance are mounted on the starfield beamsplitter assembly. The selected star group and the particular navigational star at the center of the group are finally combined by the cube starfield beamsplitter in the sextant's starfield optical path. Figure 1-57 illustrates schematically the generation of the starfield scene.

1-272. Twenty-eight stars, of apparent magnitudes ranging from -1.6 to 3.9, have been selected for celestial navigational sightings. Table 1-28 lists the navigational stars. Column one lists the star number in accordance with the accepted star list. Column two lists the positions of the rotary switch labeled **SEXTANT STARFIELD SELECTOR** on the electronics cabinet test panel. Column six lists the number of fourth, fifth, and sixth magnitude background stars visible within a four degree field around each of the navigational stars (see figure 1-59). Column seven lists the degrees and direction of rotation required for certain of the star groups in order to orient the group so that the celestial north appears to be at the top (+Y) axis on the sextant reticle. This image orientation rotation applies when the rotating reticle, starfield rotation, and rotating prism servo systems are electrically zeroed, as explained and described in Section II, Functional Test.

1-273. The first opto-electro-mechanical assembly in the starfield line of sight is the starfield generator. The mechanical schematic, (see figure 1-58), illustrates the d-c servo-motor drives and the interconnecting gearing. The principal components that form the starfield scene in the optical path are the star mask, the starfield disc, and the navigational star light beam passing through the appropriate density filter in the filter wheel. Both the star mask and the starfield disc are perforated with 70 very small holes, representing the 70 background or surround, of stars listed in table 1-28. However, the locations (X and Y coordinates) of the holes on the two discs have been calculated so that, depending on the rotation position of the star mask in relation to the position of the starfield, light rays from the starfield light source will only pass through those holes in each disc that are in line. Thus, in turn, is predicated on which particular navigational star has been commanded for presentation by the computer signals. The rotation of the star mask is divided into 28 discrete steps; at each step, or position of the star mask, one of the 28 starfields shown in figure 1-59 is presented in the starfield line of sight.. Simultaneously, the filter wheel rotates to the position that will insert the proper density filter into the path of the navigational star light beam; the proper filter being the one that will simulate the apparent magnitude (table 1-28) of the navigational star associated with the star group being displayed.

1-274. A narrative description of a typical presentation of a navigational star and its associated star group, for viewing and eventual superimposition on a preselected landmark in order to make a navigational "fix", will be helpful in understanding the function of the starfield scene generating system in the over-all sextant performance. Assume that a suitable (clearly distinguishable and not cloud obscured) landmark has been located by the telescope

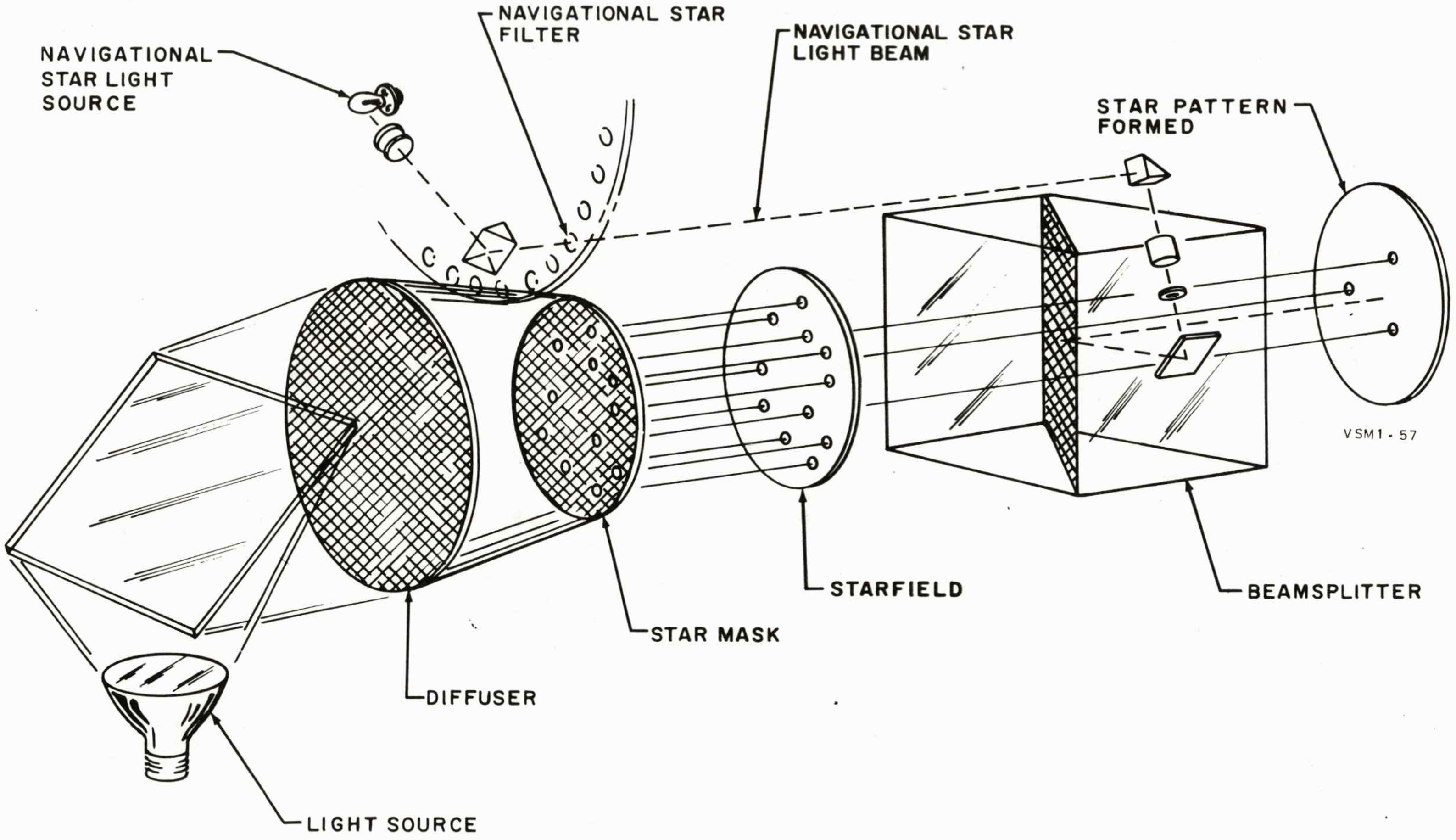


Figure 1-57. Starfield Scene Generation Schematic

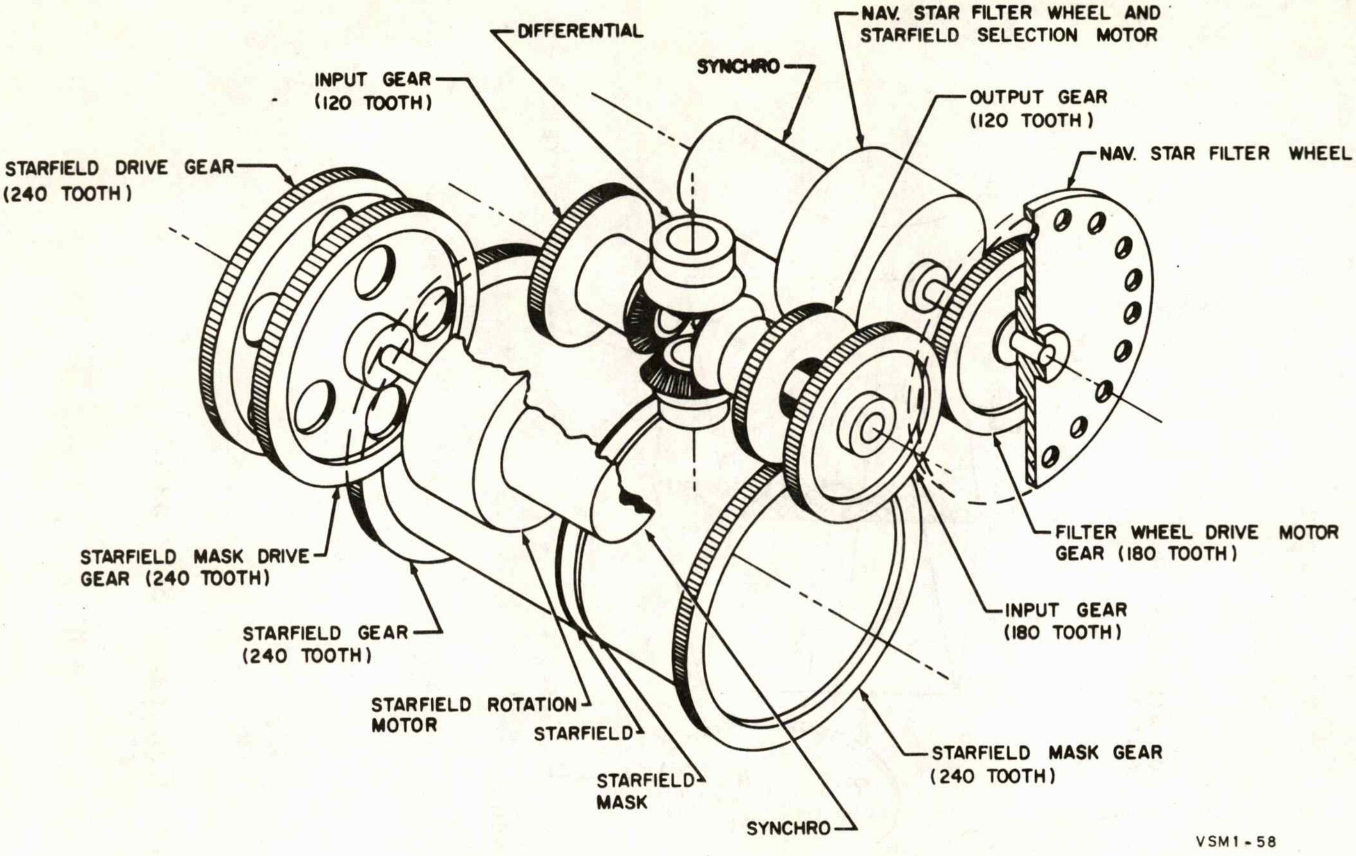
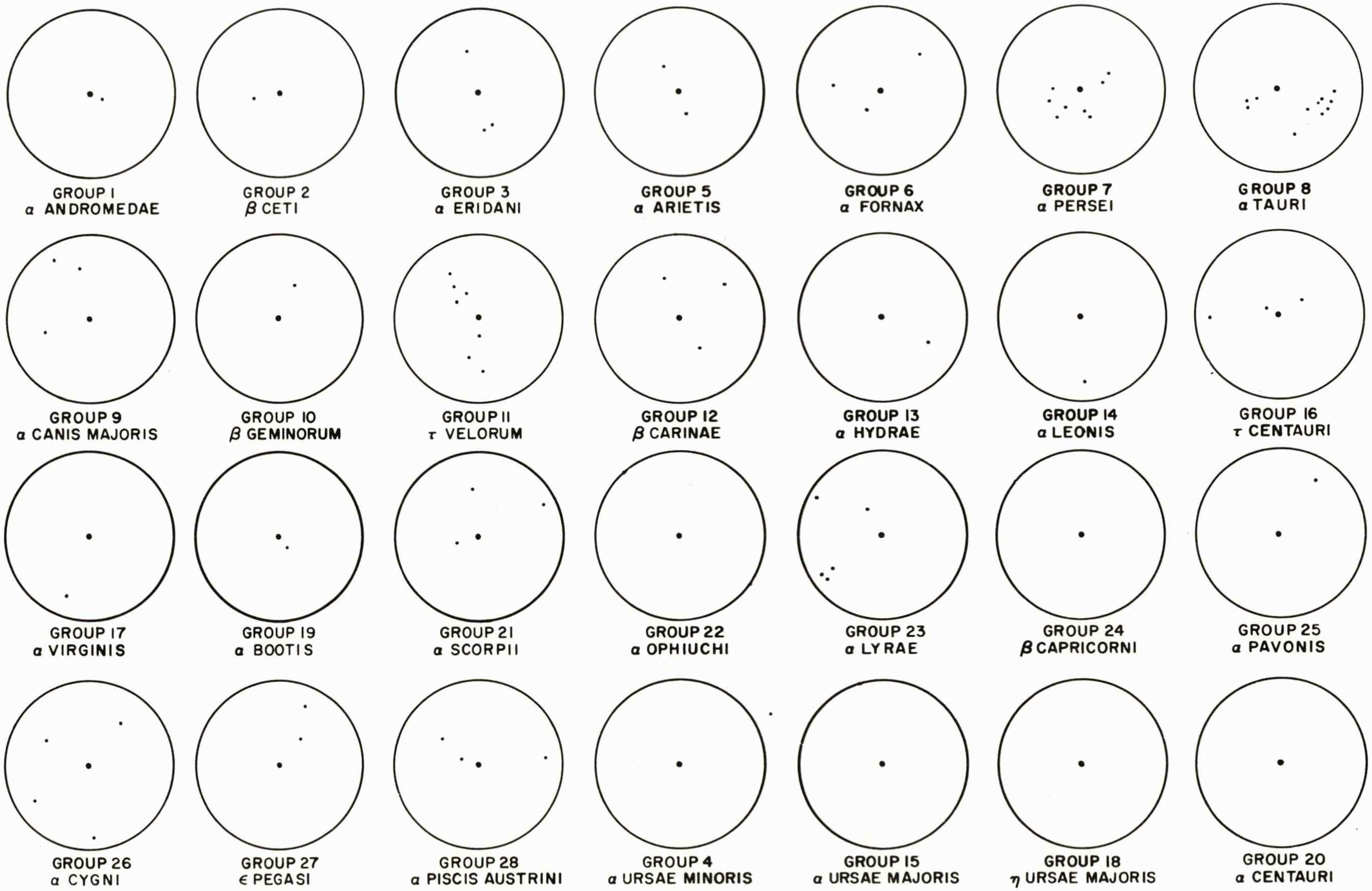


Figure 1-58. Starfield Generator Mechanical Schematic

and has been centered, within allowable limits, on the reticle of the sextant. Stabilization of the spacecraft has been accomplished and the resultant simulation is that the shaft axes of both instruments are being trained on the selected landmark, which is observed to move no further off-axis than plus or minus 0.5 degrees or the deadband of stabilization control. Secondly, assume that a navigational fix using this landmark and the navigational star α Pavonis is desired. The star-seeking capability of the telescope will function (illumination and rotation of the celestial sphere) until this star is approximately centered on the telescope's reticle. That is, the star will be within the center 2.2 degrees of the telescope's 60 degree field of view. At this point the simulator computers will transmit the required binary coded decimal (BCD) signal for presentation of star group No. 25 to the starfield selection electronics in the electronics cabinet. The BCD signal is converted to a resolver error signal and the navigational star filter wheel and the starfield selection motor in the starfield generator are energized to rotate the star mask to position 21, thus presenting star group 25 in the starfield line of sight. Simultaneously the navigational star filter wheel is rotated to the position that will insert a density filter into the navigational star light path to simulate the 2.1 apparent magnitude of Peacock, or α Pavonis. If the navigational star selected had been one of the five requiring image orientation rotation; e.g., star No. 28, Formalhaut or α



GROUP 1 α ANDROMEDAE
GROUP 2 β CETI
GROUP 3 α ERIDANI
GROUP 5 α ARIETIS
GROUP 6 α FORNAX
GROUP 7 α PERSEI
GROUP 8 α TAURI
GROUP 9 α CANIS MAJORIS
GROUP 10 β GEMINORUM
GROUP 11 τ VELORUM
GROUP 12 β CARINAE
GROUP 13 α HYDRAE
GROUP 14 α LEONIS
GROUP 16 τ CENTAURI
GROUP 17 α VIRGINIS
GROUP 19 α BOOTIS
GROUP 21 α SCORPII
GROUP 22 α OPHIUCHI
GROUP 23 α LYRAE
GROUP 24 β CAPRICORNI
GROUP 25 α PAVONIS
GROUP 26 α CYGNI
GROUP 27 ϵ PEGASI
GROUP 28 α PISCIS AUSTRINI
GROUP 4 α URSAE MINORIS
GROUP 15 α URSAE MAJORIS
GROUP 18 η URSAE MAJORIS
GROUP 20 α CENTAURI

NOTE:
THE ANGULAR POSITIONS OF THE BACKGROUND STARS WITH RELATIONSHIP TO THE NAVIGATIONAL STAR ARE APPROXIMATE IN THESE DIAGRAMS. FOR MORE EXACT DUPLICATIONS OF THE STAR GROUPS, REFER TO TABLES 8-1 AND 8-2.

Figure 1-59. Sextant Star Groups

Table 1-28. Sextant Navigational Stars

Star No.	Switch Position No.	Constellation Designation	Star's Common Name	Apparent Magnitude	Number of Stars in Surround	Image Orientation Rotation
01	1	Andromedae	Alpharatz	2.1	1	0°
02	2	Ceti	Diphda	2.2	1	0°
03	3	Eridani	Achernar	0.6	3	0°
04	25	Ursae Minoris	Polaris	2.1	0	0°
05	4	Arietis	Hamal	2.2	2	0°
06	5	Fornax	Fornax	3.9	3	5° CW
07	6	Persei	Marfak	1.9	8	0°
08	7	Tauri	Aldeberan	1.1	12	26° CW
09	8	Canis Majoris	Sirius	-1.6	4	0°
10	9	Geminorum	Pollux	1.2	1	0°
11	10	Velorum	Vela	1.9	7	0°
12	11	Carinae	Miaplaiedus	1.8	3	0°
13	12	Hydrae	Alphard	2.2	1	5° CCW
14	13	Leonis	Regulus	1.3	1	5° CW
15	26	Ursae Majoris	Dubhe	1.9	0	0°
16	14	Centauri	Centaurus	2.4	3	0°
17	15	Virginis	Spica	1.2	1	0°
18	27	Ursae Majoris	Alkaid	1.9	0	0°
19	16	Bootis	Arcturus	0.2	1	0°
20	28	Centauri	Rigel Kentaurus	0.1	0	0°
21	17	Scorpii	Antares	1.2	2	0°
22	18	Ophiuchi	Rasalhaugue	2.1	1	0°
23	19	Lyrae	Vega	0.1	5	0°
24	20	Capricorni	Capricornus	3.2	1	0°
25	21	Pavonis	Peacock	2.1	1	0°
26	22	Cygni	Deneb	1.3	4	0°
27	23	Pegasi	Enif	2.5	1	0°
28	24	Piscis Austrani	Fomalhaut	1.3	3	12° CCW

Piscus Austrani, the computers would have also transmitted an error signal to the starfield rotation motor which would cause the starfield disc and starfield mask to both rotate 12 degrees counterclockwise for proper orientation, as described in paragraph 1-272. The navigational fix is then taken when the images of navigational star and landmark are superimposed within the plus or minus 0.5 degree deadband of stabilization.

1-275. The function of the starfield rhomb scanner in the starfield line of sight is identical to that of the landmark rhomb scanner in the landmark line of sight. The individual and/or combined rotation of the mirror rhomboid and the prism rhomboid permits the observer to view, or scan, the 1.8 degree field of view over the entire 3.15 inch diameter of the starfield scene. The limited yaw, pitch, and roll motions of the command module during a navigational sighting are also a function of this component. The construction of the starfield scanner is similar to the landmark scanner. The smaller dimensions of the rhomboids are accounted for by the difference in diameter of the areas to be scanned. The two-speed servo systems used to drive the rhomboid components are identical to the servo systems in the landmark scanner. The starfield rhomb scanner is the last operable component in the starfield optical path.

1-276. The relay lens assembly in the starfield optical path relays the celestial scene from the starfield and navigational star beamsplitter, as displaced by the starfield rhomb scanner, to the starfield right angle mirror at unity (1:1) magnification. The reason for unity magnification in the starfield line of sight, as opposed to variable magnification in the landmark line of sight, has been explained in paragraph 1-267.

1-277. The starfield line of sight is deflected 90 degrees in a plane parallel to the optical bed plate, toward the starfield landmark combining beamsplitter by the starfield right angle mirror.

1-278. Combined Lines Of Sight. The combined lines of sight are composed of the starfield line of sight and the landmark line of sight. By combining the two images and projecting them on a common plane, they become superimposed. The combining of the lines of sight is explained in the following paragraphs.

1-279. The first fixed optics component in the combined lines of sight is the combining beamsplitter. The optical element consists of two right angle prisms cemented and coated to provide the combination of the landmark LOS and the starfield LOS into a single optical path, as illustrated in figure 1-60. This combined image is then directed toward the compound angle mirror.

1-280. The compound angle mirror, mounted on the optical bed plate, is oriented to deflect the combined optical paths down 32.5 degrees from the horizontal onto the plane of the rotating reticle.

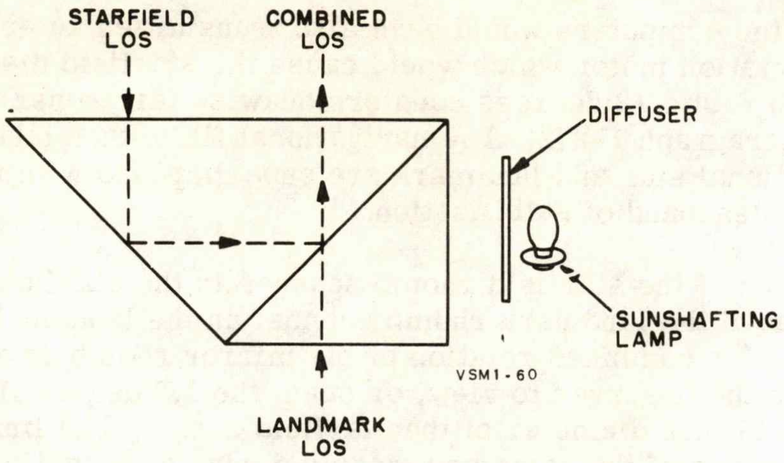


Figure 1-60. Starfield/Landmark Combining Beamsplitter

1-281. The sextant's rotating reticle is similar, but not identical, in construction with the corresponding component in the AMS telescope. The electrical components consist of a see-through type d-c motor, a pancake resolver, and a transformer coupling. The rotors of all three electrical elements are secured to the rotating barrel of the assembly, and the stators are secured in the fixed outer cylinder. The engraved reticle, illustrated in figure 2-65, duplicates the reticle of the operational sextant in appearance and is also fixed in the rotating barrel. Edge lighting is provided by four light insert assemblies threaded into the outer cylinder of the assembly. The rotating reticle's function is fulfilled by simulating the shaft axis rotation of the operational telescope. The rotating reticle assembly is mounted on the end of the optical bed plate and is the final component of the sextant attached to the bed plate.

1-282. The final opto-electro-mechanical assembly of the sextant is the rotating prism. The electrical components in the assembly are similar to, but larger than the rotating electrical components in the reticle assembly. The optical element in the assembly is a reversion prism. The prism is rotatable through 360 degrees, which causes the image on the reticle and the reticle itself to appear to rotate through 720 degrees. The function of the rotating prism in the sextant's simulation is to rotate the landmark scene around the shaft axis, thus simulating the effect of command module roll motion. Since the rotating prism is in the combined lines of sight, the simulator's computers must transmit compensatory counter-rotation signals to the rotating reticle assembly and the starfield rotation motor in the starfield generator assembly whenever the rotating prism is energized in order to maintain true simulation. The rotating prism assembly is housed in a rectangular, light-tight box which is a portion of a separate support casting dowelled and bolted directly to the sextant's supporting frame. A circular opening in the end of the rotating prism housing provides a mounting surface for the eyepiece tube assembly which projects into the command module.

1-283. The eyepiece tube assembly, mounted on the rotating prism housing provides a housing for the final relay lens assembly. The relay lens is located in the combined optical path to relay the image formed on the reticle plane to the focal plane of the eyepiece when the manual dioptic adjustment of the eyepiece is set for zero diopters. The tube assembly terminates in the eyepiece mounting panel which duplicates in appearance the corresponding panel in the operational Apollo command module.

1-284. The sextant eyepiece assembly duplicates, in appearance, the operational eyepiece, and is attached to the mounting panel by two captive socket head cap screws. A manual dipptic adjustment provides a focusing range of plus and minus two diopters. The eyepiece assembly also incorporates a manually rotatable polaroid analyzer.

1-285. In order to correctly simulate an Apollo mission, the effect of the entrance of sunlight into the sextant's optical paths must be provided. The sunshafting lamp assembly accomplishes this by lighting the small lamp mounted on the end of the optical bed. This light enters the combined optical paths through the starfield landmark combining beamsplitter and is seen as increased illumination on the reticle to the point that the landmark and/or starfield image(s) is washed out with an accompanying reduction in visual contrast. The illumination of the sunshafting lamp is controlled by an on/off signal from the computer.

1-286. Digital To Resolver Converters. Figures 1-61 and 1-62 show functional block diagrams of the DRC's associated with the sextant slide selector servo and the sextant starfield selector servo respectively. In both cases, the DRC's receive their input commands from the AMS computer complex in the form of binary coded decimal (BCD) quantities. In each case, the BCD quantities are applied to the associated DRC for conversion to analog sine and cosine voltages required by the servo's feedback resolvers.

1-287. Sextant Slide Selector Servo. During normal operations, the computer can position the sextant carousel to any one of 90 possible positions. The DRC must select the sine and cosine voltages which correspond to the angular position defined by the BCD output of the computer. Since there are 90 slides in the carousel, the angular difference between each slide position is equal to 4 degrees. Therefore, when the DRC receives a BCD output, it decodes it into one of the possible four degree increments and supplies the associated resolver with the appropriate sine and cosine values.

1-288. In order to locate the desired slide position, the DRC divides the 360 degrees of carousel rotation into 9 sections, each consisting of 40 degrees, and the appropriate 40 degrees section into 10 increments, each consisting of 4 degrees. The DRC locates the appropriate 40 degree section

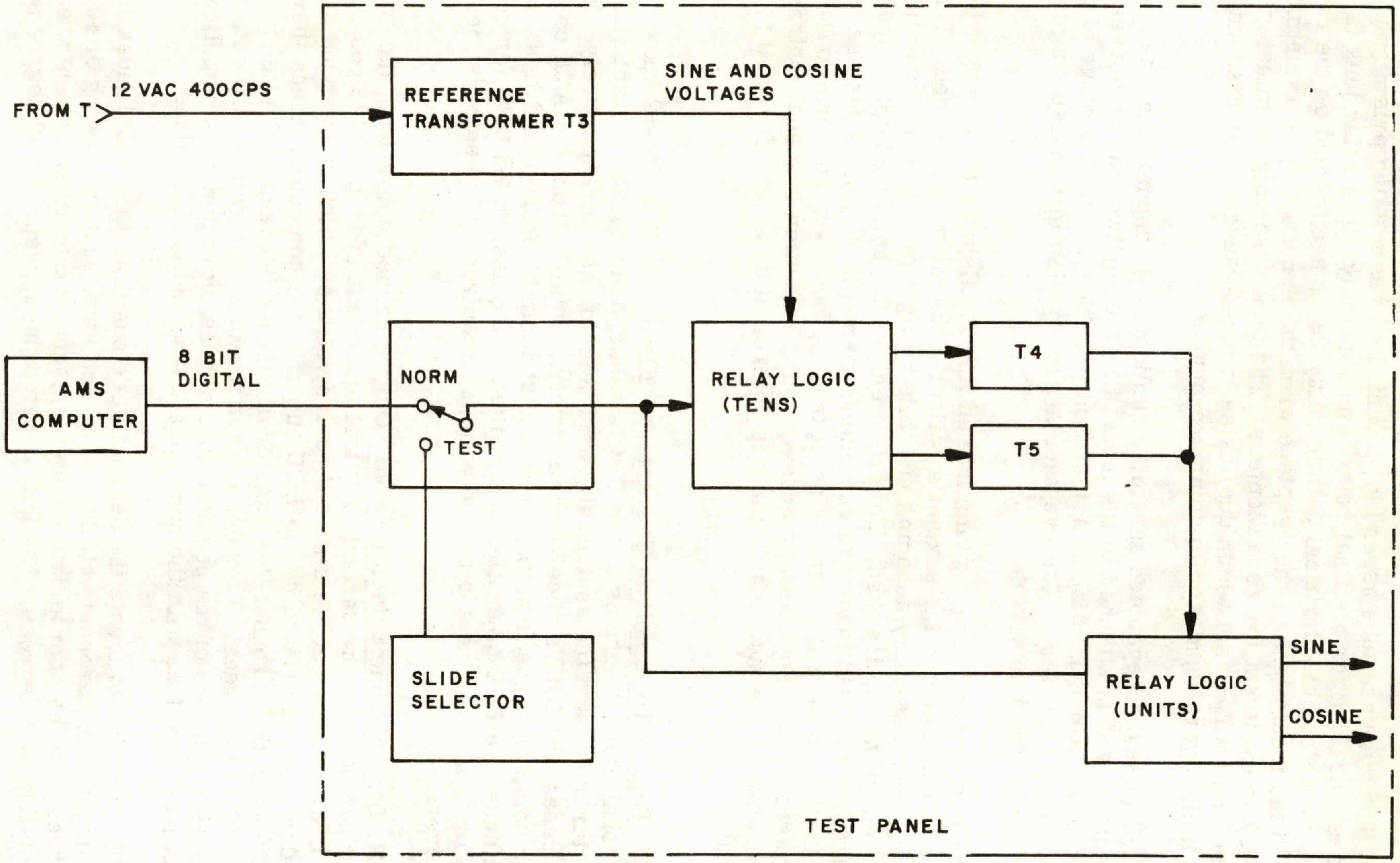


Figure 1-61. Slide Selector DRC Operation Block Diagram

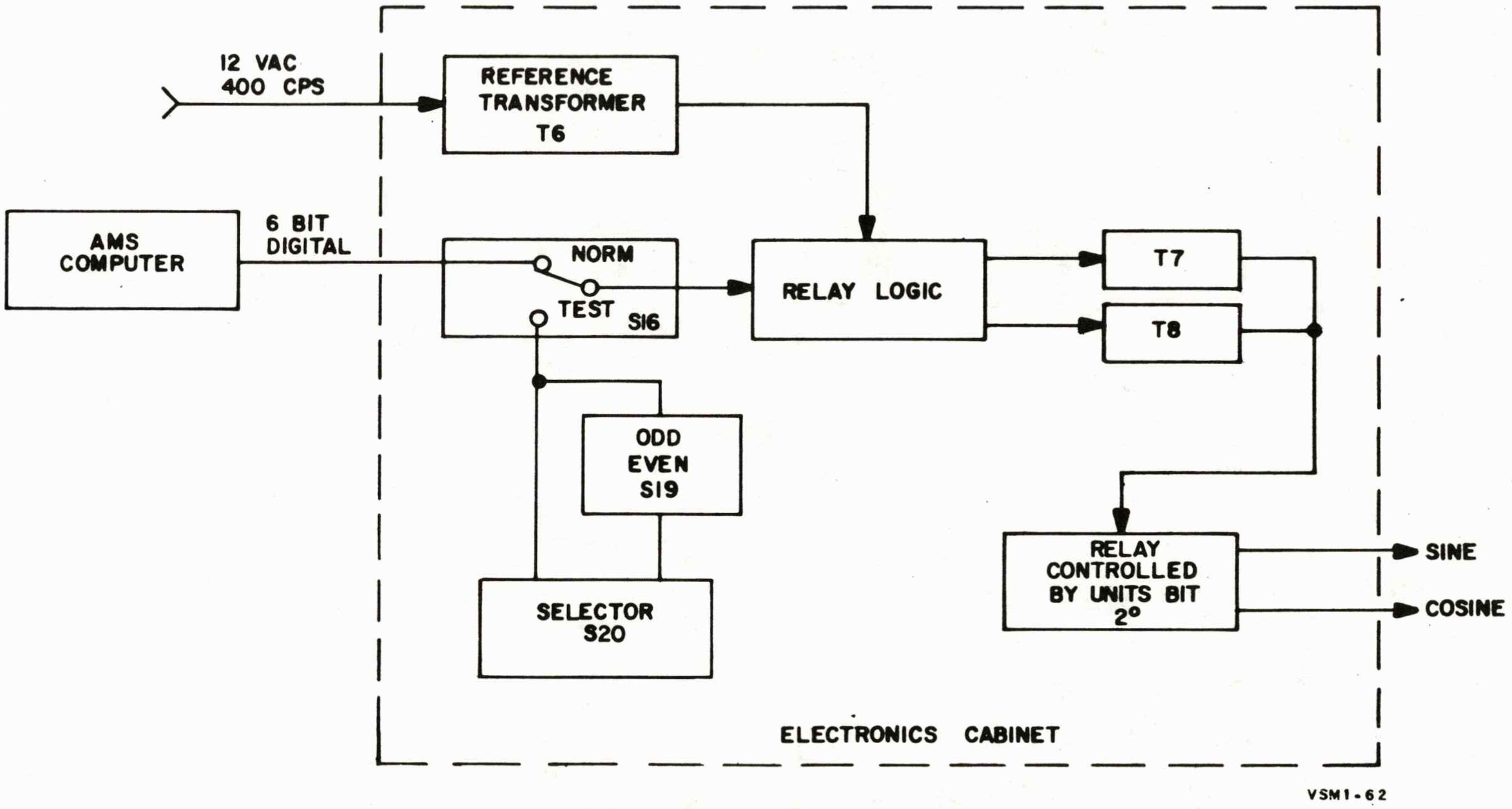


Figure 1-62. Starfield Selector DRC Operation Block Diagram

by decoding the tens portion of the BCD input. The DRC locates the appropriate four degree section by decoding the units portion of the BCD input. This action provides a sine and cosine value of the four degree section which, as indicated previously, represents a slide position. In order to provide voltages representing the desired sine and cosine values, the DRC uses the combination of transformers and relays indicated in figure 1-61. Transformer T3 provides a range of voltages which goes from the maximum positive phase (cosine zero degrees) through zero (cosine 90 degrees), to the maximum negative phase (cosine 180 degrees). The transformer secondary is tapped so that a range of sine and cosine signals is provided. Selection of the appropriate sine and cosine combination is made by relays K1 through K4. The combination of closed relay contacts selects the appropriate 40 degree increment range of values based upon the tens portion of the BCD input. The selected 40 degree range of values (developed by the required combination of closed relay contacts) determines the input signals to sine transformer T4 and cosine transformer T5. The output values of T4 and T5 depend upon the condition of relays K5 through K8. Input signals to these relays is provided by the units portion of the BCD input.

1-289. DRC Operation. The carousel and starfield DRC's function under computer and manual control. Table 1-29 lists each starfield position, the corresponding BCD value, and the state of the associated relays. Table 1-30 lists each carousel position in the same manner.

1-290. Starfield Selection. The operation of the sextant starfield selector DRC (see figure 1-62) is the same as the operation of the landmark slide selector DRC. Since the starfield filter disc has filters which are approximately 12.85 degrees apart, its DRC is required to select only 28 sets of sine and cosine values for its associated servo loop.

Table 1-29. Starfield DRC Position

Star Group Number	BCD Value	Binary Equivalent		Test Switch Position		Relays Energized	Angular Position (Degree)
		Tens	Units	No.	Odd/Even		
1	00	00	0000	1 - 2	Odd	None	0.
2	01	00	0001	1 - 2	Even	K23	12.857
3	02	00	0010	3 - 4	Odd	K13, K14, K15, K16	25.714
4	03	00	0011	3 - 4	Even	K13 - K16, K23	38.571
5	04	00	0100	5 - 6	Odd	K17, K18	51.429
6	05	00	0101	5 - 6	Even	K17, K18, K23	64.286
7	06	00	0110	7 - 8	Odd	K13 - K18	77.143
8	07	00	0111	7 - 8	Even	K13 - K18, K23	90.
9	08	00	1000	9 - 10	Odd	K19, K20	102.857
10	09	00	1001	9 - 10	Even	K19, K20, K23	115.714
11	10	01	0000	11 - 12	Odd	K21	128.571
12	11	01	0001	11 - 12	Even	K21, K23	141.429
13	12	01	0010	13 - 14	Odd	K13 - K16, K21	154.286
14	13	01	0011	13 - 14	Even	K13 - K16, K21, K23	167.143
15	14	01	0100	15 - 16	Odd	K17, K18, K21	180.
16	15	01	0101	15 - 16	Even	K17, K18, K21, K23	192.857
17	16	01	0110	17 - 18	Odd	K13 - K18, K21	205.714
18	17	01	0111	17 - 18	Even	K13 - K18, K21, K23	218.571

Table 1-29. Starfield DRC Position (Cont)

Star Group Number	BCD Value	Binary Equivalent Tens	Binary Equivalent Units	Test Switch No.	Position Odd/Even	Relays Energized	Angular Position (Degree)
19	18	01	1000	19 - 20	Odd	K19, K20, K21	231.429
20	19	01	1001	19 - 20	Even	K19, K20, K21, K23	244.286
21	20	10	0000	21 - 22	Odd	K22	257.143
22	21	10	0001	21 - 22	Even	K22, K23	270.
23	22	10	0010	23 - 24	Odd	K13 - K16, K22	282.857
24	23	10	0011	23 - 24	Even	K13 - K16, K22, K23	295.714
25	24	10	0100	25 - 26	Odd	K17, K18, K22	308.571
26	25	10	0101	25 - 26	Even	K17, K18, K22, K23	321.429
27	26	10	0110	27 - 28	Odd	K13 - K18, K22	334.286
28	27	10	0111	27 - 28	Even	K13 - K18, K22, K23	347.143

Table 1-30. Carousel DRC Position

Landmark Slide	BCD Value	Binary Equivalent		Test Switch Position		Relays Energized	Angular Position (Degree)
		Tens	Units	Tens	Units		
1	00	0000	0000	0	0	None	0
2	01	0000	0001	0	1	K9	4
3	02	0000	0010	0	2	K10	8
4	03	0000	0011	0	3	K9, K10	12
5	04	0000	0100	0	4	K11	16
6	05	0000	0101	0	5	K9, K11	20
7	06	0000	0110	0	6	K10, K11	24
8	07	0000	0111	0	7	K9, K10, K11	28
9	08	0000	1000	0	8	K12	32
10	09	0000	1001	0	9	K9, K12	36
11	10	0001	0000	10	0	K3	40
12	11	0001	0001	10	1	K3, K9	44
13	12	0001	0010	10	2	K3, K10	48
14	13	0001	0011	10	3	K3, K9, K10	52
15	14	0001	0100	10	4	K3, K11	56
16	15	0001	0101	10	5	K3, K9, K11	60
17	16	0001	0110	10	6	K3, K10, K11	64
18	17	0001	0111	10	7	K3, K9, K10, K11	68

Table 1-30. Carousel DRC Position (Cont)

Landmark Slide	BCD Value	Binary Equivalent Tens	Binary Equivalent Units	Test Switch Position Tens	Test Switch Position Units	Relays Energized	Angular Position (Degree)
19	18	0001	1000	10	8	K3, K12	72
20	19	0001	1001	10	9	K3, K9, K12	76
21	20	0010	0000	20	0	K5	80
22	21	0010	0001	20	1	K5, K9	84
23	22	0010	0010	20	2	K5, K10	88
24	23	0010	0011	20	3	K5, K9, K10	92
25	24	0010	0100	20	4	K5, K11	96
26	25	0010	0101	20	5	K5, K9, K11	100
27	26	0010	0110	20	6	K5, K10, K11	104
28	27	0010	0111	20	7	K5, K9, K10, K11	108
29	28	0010	1000	20	8	K5, K12	112
30	29	0010	1001	20	9	K5, K9, K12	116
31	30	0011	0000	30	0	K3, K5	120
32	31	0011	0001	30	1	K3, K5, K9	124
33	32	0011	0010	30	2	K3, K5, K10	128
34	33	0011	0011	30	3	K3, K5, K9, K10	132
35	34	0011	0100	30	4	K3, K5, K11	136
36	35	0011	0101	30	5	K3, K5, K9, K11	140

Table 1-30. Carousel DRC Position (Cont)

Landmark Slide	BCD Value	Binary Equivalent Tens	Binary Equivalent Units	Test Switch Position Tens	Test Switch Position Units	Relays Energized	Angular Position (Degree)
37	36	0011	0110	30	6	K3, K5, K10, K11	144
38	37	0011	0111	30	7	K3, K5, K9, K10, K11	148
39	38	0011	1000	30	8	K3, K5, K12	152
40	39	0011	1001	30	9	K3, K5, K9, K12	156
41	40	0100	0000	40	0	K7	160
42	41	0100	0001	40	1	K7, K9	164
43	42	0100	0010	40	2	K7, K10	168
44	43	0100	0011	40	3	K7, K9, K10	172
45	44	0100	0100	40	4	K7, K11	176
46	45	0100	0101	40	5	K7, K9, K11	180
47	46	0100	0110	40	6	K7, K10, K11	184
48	47	0100	0111	40	7	K7, K9, K10, K11	188
49	48	0100	1000	40	8	K7, K12	192
50	49	0100	1001	40	9	K7, K9, K12	196
51	50	0101	0000	50	0	K3, K7	200
52	51	0101	0001	50	1	K3, K7, K9	204
53	52	0101	0010	50	2	K3, K7, K10	208
54	53	0101	0011	50	3	K3, K7, K9, K10	212

Table 1-30. Carousel DRC Position (Cont)

		Binary Equivalent		Test Switch Position			
Landmark Slide	BCD Value	Tens	Units	Tens	Units	Relays Energized	Angular Position (Degree)
55	54	0101	0100	50	4	K3, K7, K11	216
56	55	0101	0101	50	5	K3, K7, K9, K11	220
57	56	0101	0110	50	6	K3, K7, K10, K11	224
58	57	0101	0111	50	7	K3, K7, K9, K10, K11	228
59	58	0101	1000	50	8	K3, K7, K12	232
60	59	0101	1001	50	9	K3, K7, K9, K12	236
61	60	0110	0000	60	0	K5, K7	240
62	61	0110	0001	60	1	K5, K7, K9	244
63	62	0110	0010	60	2	K5, K7, K10	248
64	63	0110	0011	60	3	K5, K7, K9, K10	252
65	64	0110	0100	60	4	K5, K7, K11	256
66	65	0110	0101	60	5	K5, K7, K9, K11	260
67	66	0110	0110	60	6	K5, K7, K10, K11	264
68	67	0110	0111	60	7	K5, K7, K9, K10, K11	268
69	68	0110	1000	60	8	K5, K7, K12	272
70	69	0110	1001	60	9	K5, K7, K9, K12	276
71	70	0111	0000	70	0	K3, K5, K7	280
72	71	0111	0001	70	1	K3, K5, K7, K9	284

Table 1-30. Carousel DRC Position (Cont)

Landmark Slide	BCD Value	Binary Equivalent Tens	Binary Equivalent Units	Test Switch Position Tens	Test Switch Position Units	Relays Energized	Angular Position (Degree)
73	72	0111	0010	70	2	K3, K5, K7, K10	288
74	73	0111	0011	70	3	K3, K5, K7, K9, K10	292
75	74	0111	0100	70	4	K3, K5, K7, K11	296
76	75	0111	0101	70	5	K3, K5, K7, K9, K11	300
77	76	0111	0110	70	6	K3, K5, K7, K10, K11	304
78	77	0111	0111	70	7	K3, K5, K7, K9, K10, K11	308
79	78	0111	1000	70	8	K3, K5, K7, K12	312
80	79	0111	1001	70	9	K3, K5, K7, K9, K12	316
81	80	1000	0000	80	0	K8	320
82	81	1000	0001	80	1	K8, K9	324
83	82	1000	0010	80	2	K8, K10	328
84	83	1000	0011	80	3	K8, K9, K10	332
85	84	1000	0100	80	4	K8, K11	336
86	85	1000	0101	80	5	K8, K9, K11	340
87	86	1000	0110	80	6	K8, K10, K11	344
88	87	1000	0111	80	7	K8, K9, K10, K11	348
89	88	1000	1000	80	8	K8, K12	352
90	89	1000	1001	80	9	K8, K9, K12	356

1-291. TELESCOPE/SEXTANT ELECTRONICS CABINET. In the AMS telescope/sextant subsystem, the same visual stimuli are produced as in the actual spacecraft. Dynamic changes in the visual scenes are produced by projection devices and by the movement of variable positions optics, all of which are under contsant computer control. The visual scenes are generated by projection devices within the AMS sextant and telescope, and their apparent movement is controlled by the positioning of the optical elements. These optical elements are maintained in their dynamically correct positional relationship by means of signals that are generated in digital form by the AMS computer complex, converted to analog voltages by suitable conversion equipment, and applied to servo mechanisms in the AMS sextant and telescope via circuitry in the electronics cabinet. From the biginning of the simulated flight these signals orient the optics and control the projection devices to present a "flight-in-progress" appearance to the human eye.

1-292. Circuitry controlled by the electronics cabinet can be considered as being of three basic types. First there is the servo control circuitry, which drives all of the servos associated with the sextant and telescope. Second, there is the carousel slide actuation electronics circuitry, which although not a part of the cabinet is considered as a subsection. This circuitry consists of a limit-switch-controlled motor drive and associated electronics which together control the timing for slide injection and extraction. Third, there is the ancillary equipment which is used for the generation and distribution of primary power, test and maintenance, digital-to-resolver conversion, and cooling. Equipment which permits manual adjustment to the sextant and telescope is included.

1-293. The electronics cabinet contains electronic control circuits for the illumination sources in the sextant and telescope. The controls regulate the status and intensity of the various lamps used in the equipment. Some of the circuits provide computer control of the associated lamps and others provide manual control at the cabinet itself.

1-294. TELESCOPE/SEXTANT SERVO CONTROL. The electronic control system used to position the telescope and sextant optics consists of 15 separate servomechanisms. Four of these servomechanisms are associated with the telescope, and 11 are associated with the sextant. While each of these servomechanisms is somewhat different, they can be categorized in three major groups consisting of one-speed a-c servo motor powered servos, one-speed d-c torque motor powered servos, and two-speed d-c torque motor powered servos. The 15 mechanisms are broken down into 3 basic groups as shown on table 1-31.

Table 1-31. Telescope/Sextant Servo Functions

Name	Type	Function
Variable Magnification	One Speed A-C	Drives the magnification assembly to provide simulation of various distance away from landmark.
Carousel	One Speed A-C	Drives the sextant carousel to the computer selected position.
Telescope Vertical Occulting	One Speed A-C	Controls movement of the vertical occulting blade.
Telescope Right Occulting	One Speed A-C	Controls movement of the right occulting blade.
Telescope Left Occulting	One Speed A-C	Controls movement of the left occulting blade.
Rotating Polaroid	D-C Torque Motor	Provides for the varying brightness of the landmark image.
Sextant Reticle	D-C Torque Motor	Provides for the varying brightness of the landmark image.
Sextant Reticle	D-C Torque Motor	Provides for the rotation of the sextant reticle.
Telescope Reticle	D-C Torque Motor	Drives the telescope reticle through 360 degrees of rotation.
Sextant Rotation Prism	D-C Torque Motor	Drives the prism to simulate rotation of the field of view.
Starfield Rotation	D-C Torque Motor	Rotates the starfield disc.
Starfield Mask	D-C Torque Motor	Rotates the starfield mask.
Landmark Scanner Alpha	Two Speed D-C Torque Motor	Rotates the landmark Alpha rhomb prism.
Landmark Scanner Beta	Two Speed D-C Torque Motor	Rotates the landmark Beta rhomb prism.

Table 1-31. Telescope/Sextant Servo Functions (Cont)

Name	Type	Function
Starfield Scanner Alpha	Two Speed D-C Torque Motor	Rotates the starfield Alpha rhomb prism.
Starfield Scanner Beta	Two Speed D-C Torque Motor	Rotates the starfield Beta rhomb prism.

1-295. All of these servos use resolvers as feedback elements. In each case a resolver is used to measure the actual position of the driven member, compare it with the desired position, and develop an error signal. This error signal, after further processing, is ultimately used to control the position of the driven member. With the exception of the carousel servo and the starfield mask servo, the resolver command signals are supplied by external controls or conversion equipment. In the case of the carousel and starfield mask servos, the basic positioning information is supplied in digital form and converted to resolver excitation signals by conversion equipment installed in the electronics cabinet.

1-296. A-C Servos. Figure 1-63 shows a basic block diagram of a typical a-c servo used in the telescope and sextant simulation. As shown, all command signals are routed via the "norm" contacts of the associated TEST/NORM switch on the test panel and applied to a telescope or sextant resolver which is geared to a motor-generator. The resolver develops an error signal which is fed back to the electronics cabinet. This signal is amplified, and applied to the windings of the associated servo motor which drives the opto-mechanical load until the resolver nulls. Servo systems schematics are included in Section VIII.

1-297. One-Speed D-C Servos. Figure 1-64 is a basic block diagram of a typical d-c servo. As indicated, all command signals are routed via the "norm" contacts of the associated test panel TEST/NORM switch and applied to a feedback resolver geared to a d-c torque motor. As is the case with the a-c servos, the resolver develops an error signal which is fed back to the electronics cabinet. There it is amplified, and applied to the windings of the motor which drives the opto-mechanical load until the resolver nulls. For improved performance, each d-c servo uses dynamic compensation and stabilization as provided by a lead-lag network built into the electronics package. The time constant of this network is controlled by an externally mounted capacitor.

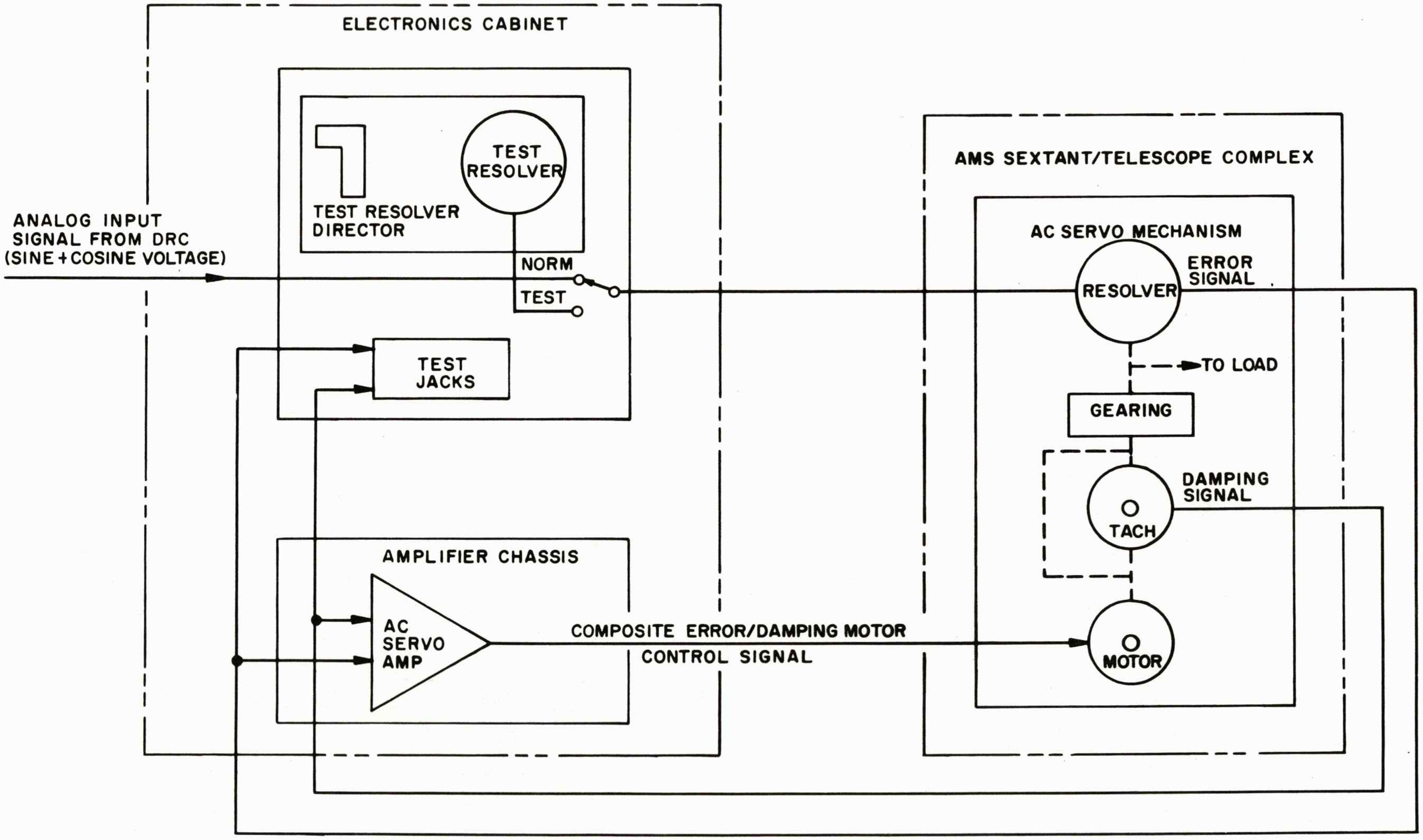


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Figure 1-63. Typical Telescope/Sextant System AC Servo (Block Diagram)

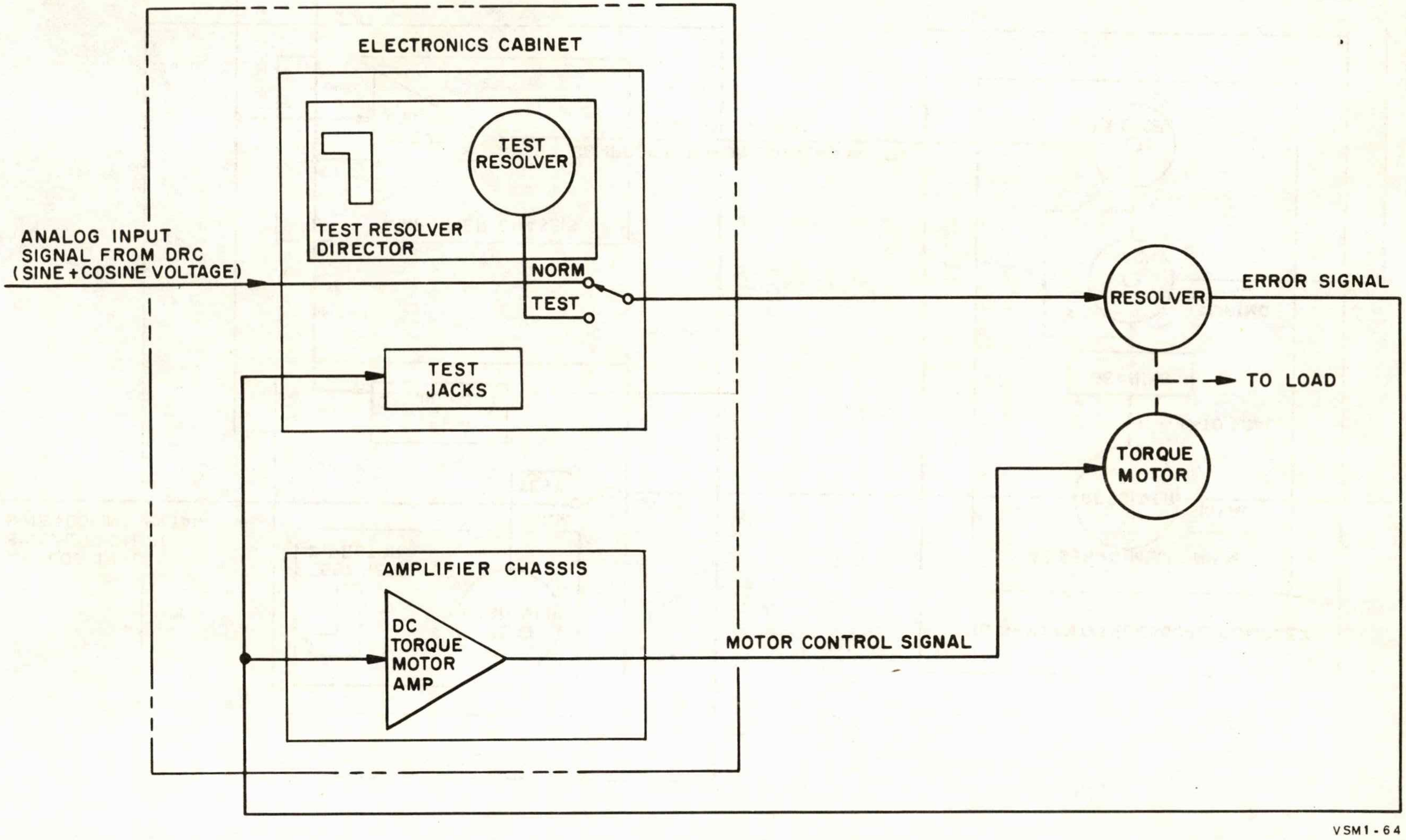


Figure 1-64. Typical Telescope/Sextant System DC Servo (Block Diagram)

1-298. Two-Speed D-C Servos. Four essentially identical two-speed servos are used in the AMS sextant. Two of these servos, consisting of the Alpha landmark scanning servos and the Beta landmark scanning servo, are employed in the landmark scanning assembly. The other two servos, consisting of the starfield Alpha scanner servo and starfield Beta scanner servo are employed in the starfield scanning subassembly.

1-299. The purpose of the landmark Alpha and Beta scanner servos is to allow displacement in two dimensions of the image generated by the landmark slide according to signals from the computer. These servos allow image displacement throughout a certain range by employing a curvilinear coordinate system; they do not scan in the usual rectangular x-y coordinates.

1-300. From an electrical and systems standpoint, these servos are essentially identical. The only difference existing between them lies in the range of their variables (Alpha and Beta). The total angular range of the Alpha variable is less than 180 degrees, while the total angular range of the Beta variable is just under 360 degrees. The servos themselves are both one speed and 32 speed servos, meaning that in each case two resolver control transformers are employed. The high speed (or 32 speed) resolver is coupled directly to the servo motor shaft as part of an assembly that is very similar to that used in the rotating polaroid servo. The low speed (or one speed resolver) is coupled to this motor shaft via 32:1 gearing. This resolver coarsely establishes the angular position of the servo output shaft. Once the servo is within a few degrees of its correct position, semiconductor switching in the associated d-c torque motor electronics circuitry switches control of the loop to the 32 speed resolver. The 32 speed resolver then maintains loop control until the servo reaches its final position. This arrangement gives 32 times the accuracy that can be obtained with single speed servos. An additional gear reduction of 6:1 connects the 1-speed shaft to the load, giving a total reduction of 192:1 between the d-c torque motor shaft and the shaft of the scanner itself.

1-301. The starfield Alpha and Beta scanner servos are located on the starfield scanning subassembly and are used to displace the starfield image in the same manner and with the same coordinate system as employed by the landmark scanning assembly.

1-302. A-C Servo Amplifiers. Figure 1-65 is a functional block diagram illustrating the overall relationships that exist among the major sections in a typical a-c servo amplifier. As indicated in the overall description of the a-c servos, the output of the resolver control transformer is proportional to the sine of the angular difference between the present rotor position and the rotor position defined by the voltages applied to the stator windings. This output is an error signal which is applied to a summing network in the amplifier where it is combined with the tachometer output signal from the servo motor-generator set. The combined error and tachometer signals are then amplified and applied to a push-pull output stage whose output is transformer

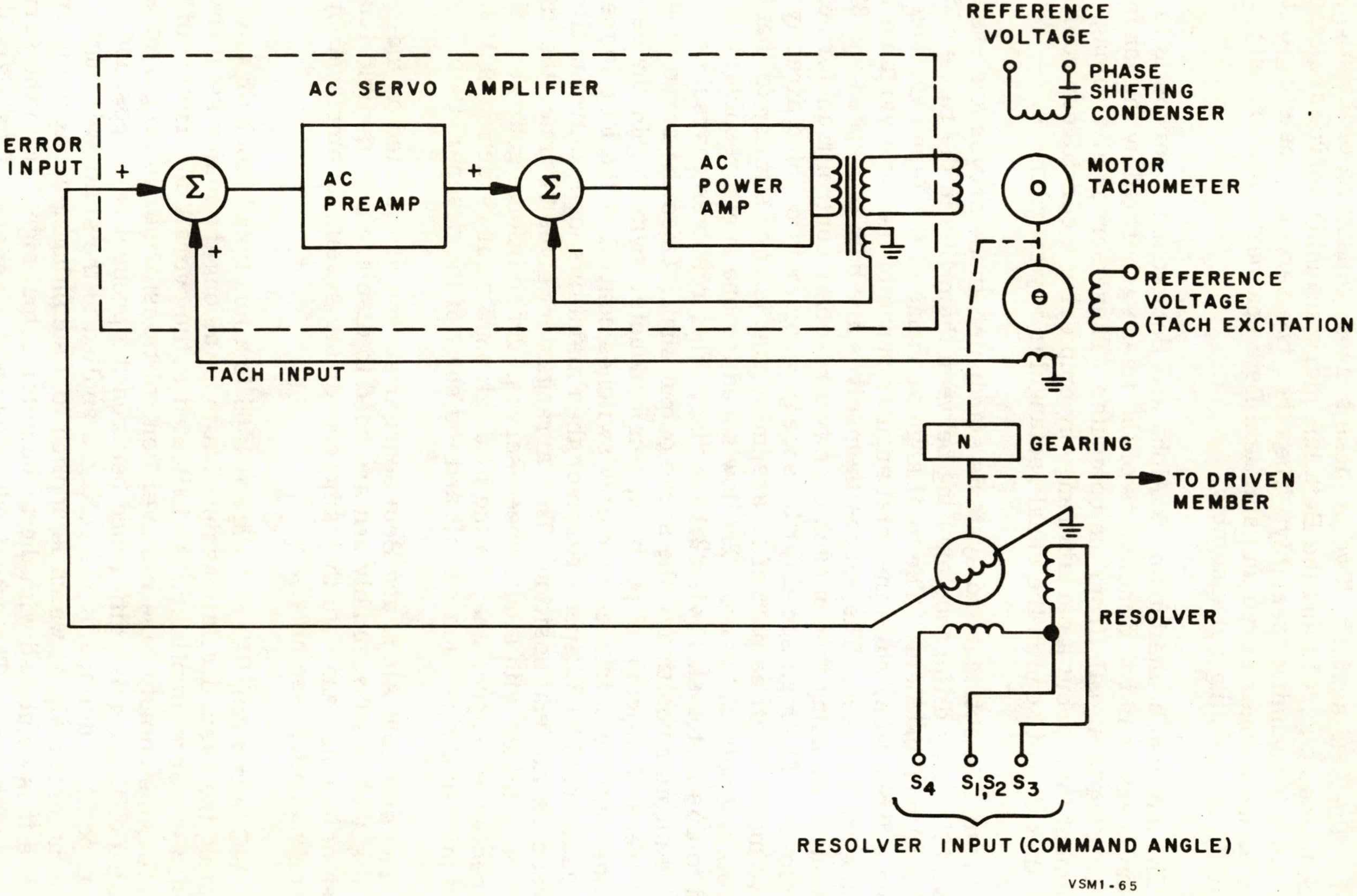


Figure 1-65. AC Single Speed Servo (2Ø AC Servometer Drive)

coupled to the windings of the a-c servo motor. The motor drives its associated gearing until the resolver rotor is positioned to the command angle, thereby reducing the error to zero and stopping the motor. During amplifier operation, a portion of the output signal is taken from the secondary of the output transformer and fed back to the amplifier where it is used as degenerative feedback to improve amplifier stability, linearity, and output impedance.

1-303. D-C Torque Motor Electronics. Figure 1-66 is a functional block diagram illustrating the overall relationships that exist among the major d-c torque motor electronics sections. Starting at the input terminals, the circuitry consists of a semiconductor two-speed switching network which is summed with a single speed input circuit and followed by a protective limiter. Following this is a 3-stage high gain a-c amplifier driving a phase sensitive demodulator whose output is applied to an 800-cycle ripple filter. The output of this filter is applied to a lead-lag compensation network that supplies the input to a 50-watt d-c feedback amplifier that is used to drive the associated d-c torque motor. The d-c torque motor electronics output is from 0 to 10 volts of either polarity with an output current of up to 5 amps.

1-304. Carousel Slide Actuation Electronics. The purpose of this circuitry is to provide an electrical indication, in the form of a relay closure, indicating when the servo has come to a complete stop or when the slide injection mechanism can be safely cycled. In its operation, the slide injection mechanism must be actuated as soon as possible, in a manner consistent with safety and dependable operation, so that as short a slide change cycle as possible may be obtained. The length of time required for carousel rotation varies from cycle to cycle, since it may be required to slew between any 2 of its 90 possible positions. The function of the carousel slide actuation electronics is to determine when the carousel rotation phase of the cycle is complete and the slide injection phase is to begin. Since the servo is allowed to be slightly oscillatory in the interest of high speed and good performance, the error passes through zero at least once with relatively high velocity. Actuation of the slide injection mechanism under these circumstances would cause extensive damage to the equipment. Any typical servo has the property so that immediately after the receipt of a step command, velocity is zero even though the error may be large. However, in a linear or quasi-linear system, the zero values for position and velocity do not occur at the same time. Consequently, a satisfactory method for determining when carousel rotation has ceased requires that the absolute value of error and velocity magnitudes must each be below certain threshold values. This condition insures that the carousel rotation servo has stopped.

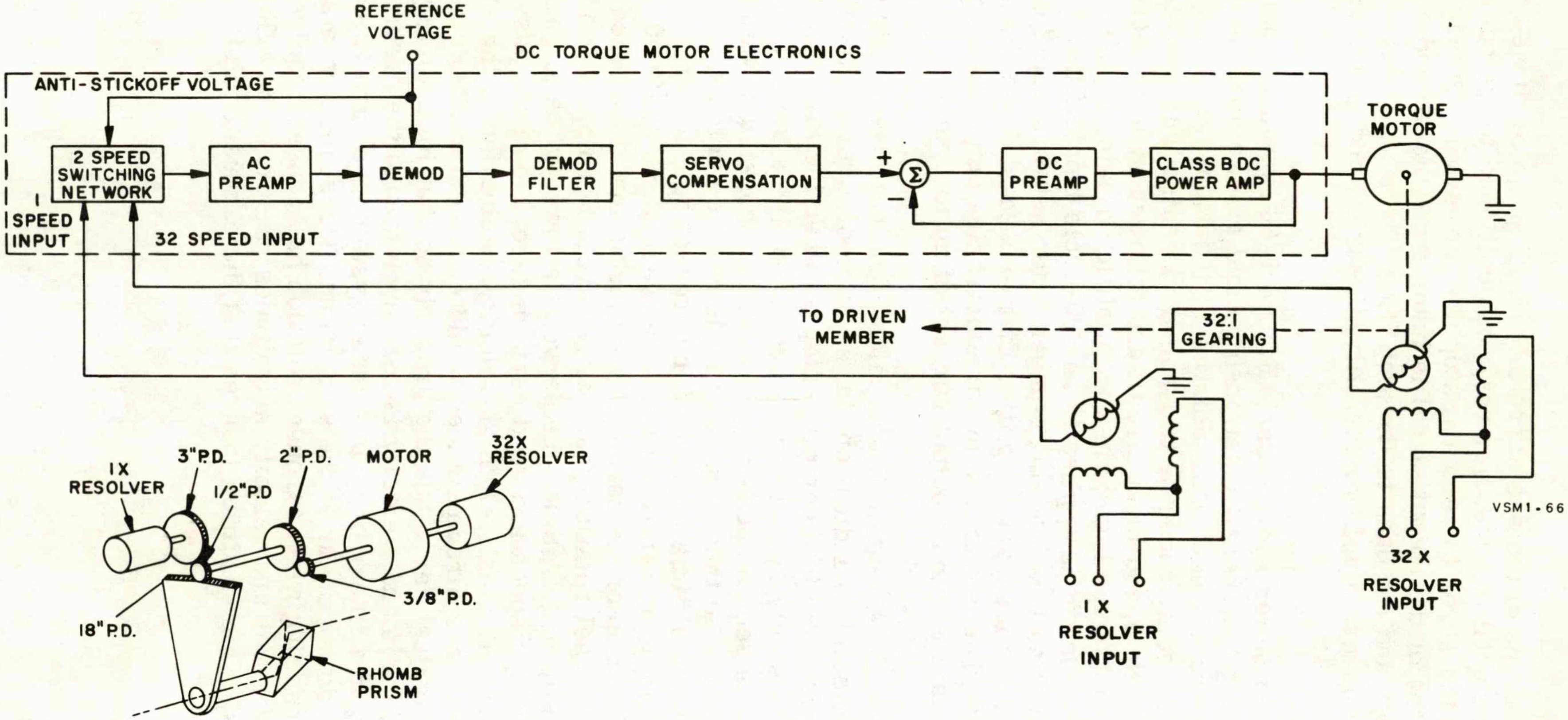


Figure 1-66. Two Speed DC Torque Motor Drive Servo

1-305. "OUT-THE-WINDOW" DISPLAY.

1-306. The "out-the-window" display systems provide visual cues for a realistic and comprehensive training program. This section describes only the equipment of the two rendezvous and docking windows as the basic principles for the two landing window optical assemblies are identical. The windows display a view of the earth below in its true relative position against a background of stars, which are also in their true relative positions. These scenes are presented as collimated virtual images which appear at an infinite distance away. The window optics are mainly reflective optics with refractive aberration correction. They are designed so that the exit pupil is located very near to the exit pupil of the command module. This allows the most realistic image possible with a maximum amount of freedom of motion on the part of the trainee.

1-307. In addition to the earth scene and starfield, the rendezvous and docking windows may provide an image of the target vehicle during transposition and rendezvous and docking maneuvers. Whenever the target vehicle and the command module are separated by a distance of less than 150 feet, the image of the target vehicle is decollimated and the image shows a parallax with respect to the stars and earth. All of the images in the four windows appear properly oriented and positioned with respect to the command module, not only within each window, but also from window to window.

1-308. All of the window displays operate on basically the same principles and are only structurally different, therefore only the rendezvous and docking window display is described in detail with only the major differences noted.

1-309. **RENDEZVOUS AND DOCKING WINDOWS.** The rendezvous and docking windows are a three input infinity projection system. Resolution is limited only by the human eye and/or image generator (the resolution of the TV-generated image is limited by the raster of the television screen. This arrangement permits maximum freedom of movement within the SCM while maintaining visual contact with the outside world through the window. The external field of view is framed by the window outline as it would appear during an actual mission. The physical location of the various optical components is shown in figure 1-10.

1-310. Image framing is achieved by providing a wider field of view through the window than is necessary for a centrally located observer. When the seated trainee moves his head to one side of the window frame, the frame uncovers part of the external view while the opposite side of the frame covers a corresponding portion of the external view. In the exit pupil, differing fields of view are provided for each eye, as will be the case in a through-the-window view during an actual mission. This realism is affected with a collimated display which precludes parallax, since the view is projected by the infinity window.

1-311. These windows achieve the superposition and subsequent infinity projection of the images generated by three input image generators, namely: the TV input image generator, the MEP input image generator, and the occulting celestial sphere (C/S) star image generator. The optical features of the windows are described in following paragraphs. The optical path is described by following the illumination path projected by each of these three image generators.

1-312. Optical Path Of The TV Input. Illumination of the television input image is shown in figure 1-11 as diverging from the TV screen into incidence with beamsplitter No. 5 which reflects it into incidence with mirror No. 3. The path of illumination after reflection from mirror No. 3 is shown at the center of the figure. Mirror No. 3 reflects the incident illumination via beamsplitter No. 5, corrector lens No. 2, beamsplitter No. 2 and corrector lens No. 1 to a focal surface coinciding with the common focal surface of spherical mirrors Nos. 1, 2, 3, and 4. Illumination diverging from this focal surface is reflected by beamsplitter No. 1 into incidence with mirror No. 1 which projects the illumination as a collimated beam focused apparently at infinity through beamsplitter No. 1 and the capsule window to the astronaut.

1-313. Optical Path Of The MEP Input. Illumination of the MEP input image is shown on figure 1-11 as diverging from the MEP screen into incidence with beamsplitter No. 6. From here it is reflected into incidence with mirror No. 4 which relays this illumination via the beamsplitters No. 6, 3 and 2, and corrector lens No. 1, to a focal surface coinciding with the common focal surface of the spherical mirrors (Nos. 1, 2, 3 and 4). Illumination diverging from this focal surface is reflected by beamsplitter No. 1 into incidence with mirror No. 1 which projects the reflected illumination through beamsplitter No. 1 and the capsule window.

1-314. Optical Path Of The Celestial Sphere Input. The celestial sphere (C/S) provides a wide field, earth/moon and target vehicle occultable view, comprised of individual, parallax-free star images. Each star image simulates, in position, color, and luminous intensity, a particular star of the true celestial sphere.

1-315. The (C/S) image is provided by the occulting celestial sphere star image generator. This C/S generator is comprised of the rendezvous and docking occulting and illumination system (refer to paragraphs 1-98 through 1-105). The illumination (see figure 1-67) starts at a lamp, and proceeds through the earth-moon and target vehicle occulting assemblies, to a focus defined as the point source of illumination. From this point the light beam spreads out and illuminates the surface of the celestial sphere. The light coming in contact with the black portions of the celestial sphere surface is absorbed. Light coming in contact with the bearing balls imbedded in the sphere (see figure 1-68) is reflected as a virtual image of the point source of illumination. The illumination reflected from the bearing balls is imaged on beamsplitter No. 4

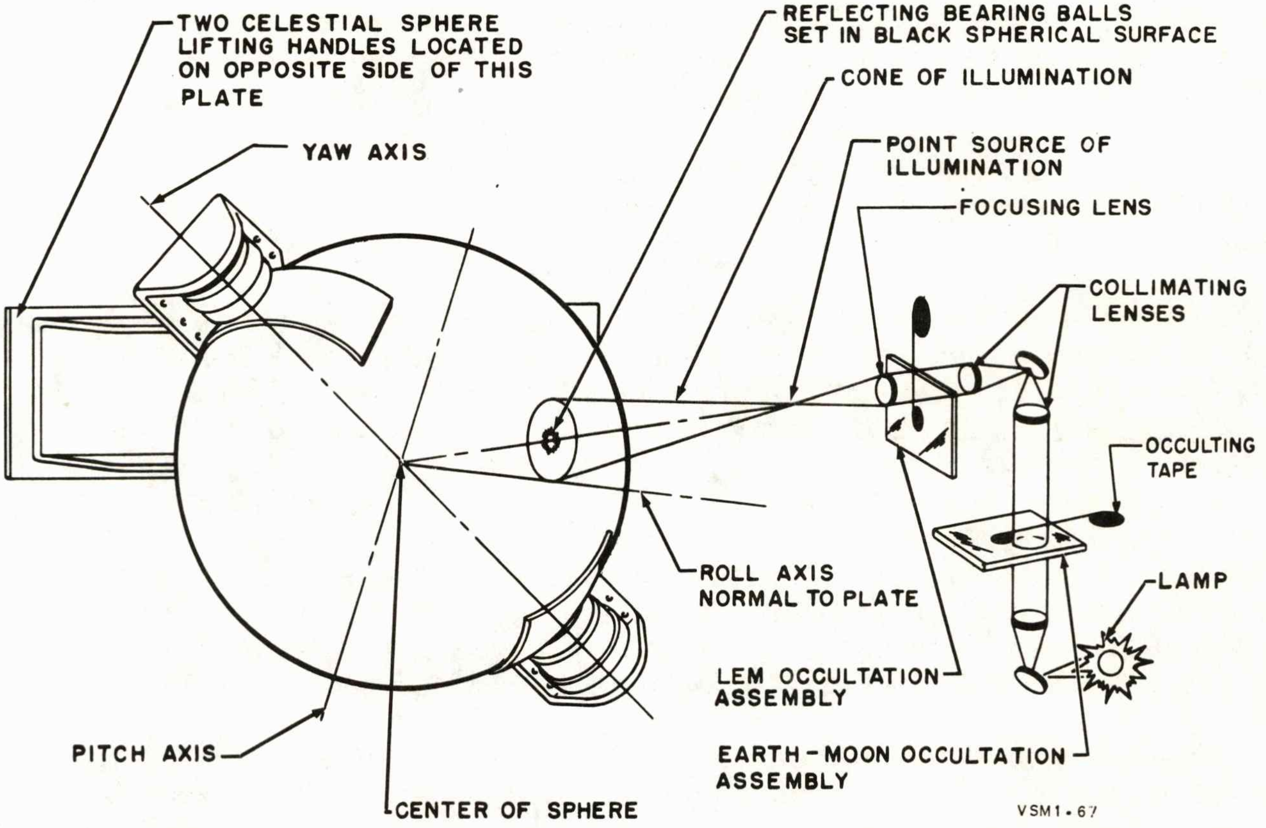


Figure 1-67. R and D Window C/S Illumination and Occultation Schematic

which reflects an adequate percentage of this illumination into the aperture of mirror No. 2. From this point it is relayed through three beamsplitters and corrector lens No. 1 to a focal surface coinciding with the common focal surface of the spherical mirrors. Illumination radiating from this common focal surface is reflected by beamsplitter No. 1 into incidence with mirror No. 1. Mirror No. 1 reflects the illumination as a collimated beam which passes through beamsplitter No. 1 and the exit pupil of the window. This provides an appropriately occulted image of the C/S upon which the TV input image and MEP input image appear superimposed.

1-316. The earth/moon occultation assembly and the LEM occultation assembly are composed of identical X and Y axis servo driven carriages. These position the center of an opaque tape spindle at varying positions within the beam of illumination, in accordance with computer commands. This two-dimensional positioning capability provides occultation of the celestial sphere illumination as required for simulating the blanking out effect created by the earth or moon, and by the target vehicle during various stages of a mission.

1-317. The tape spindle is mounted on a ring gear whose servo-energized rotation, in accordance with computer commands, causes a winding up or

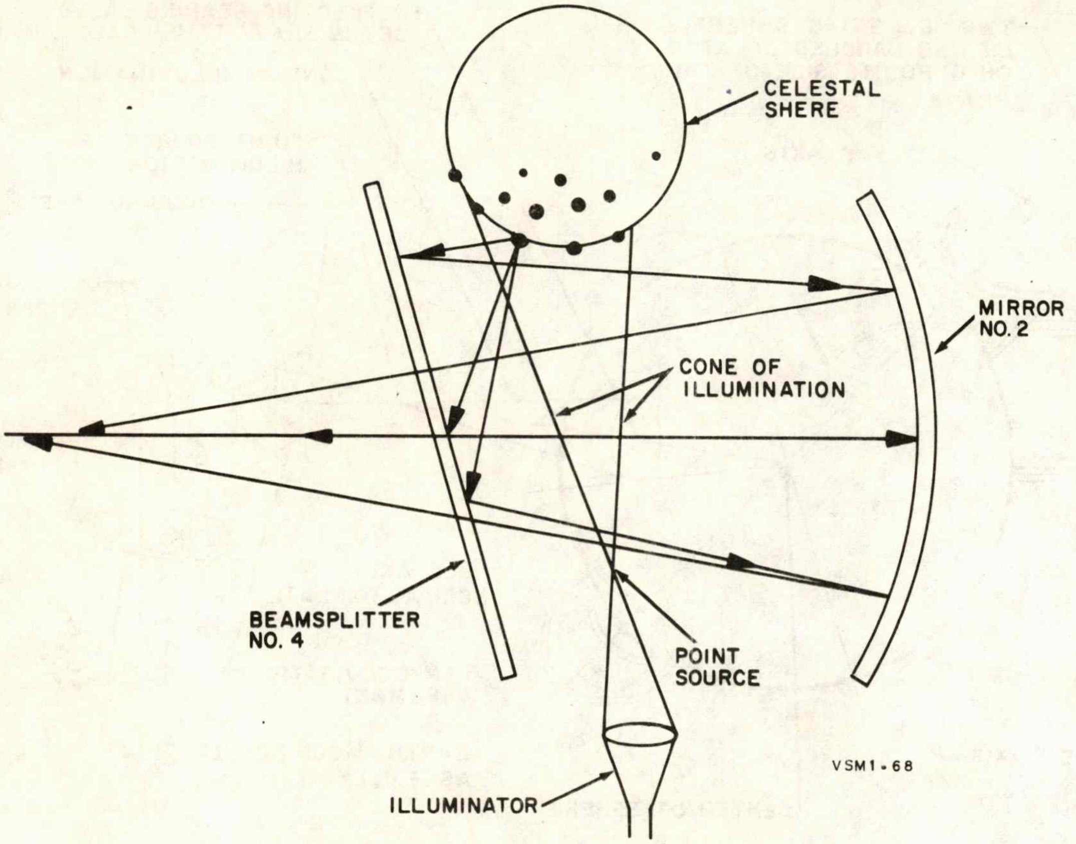
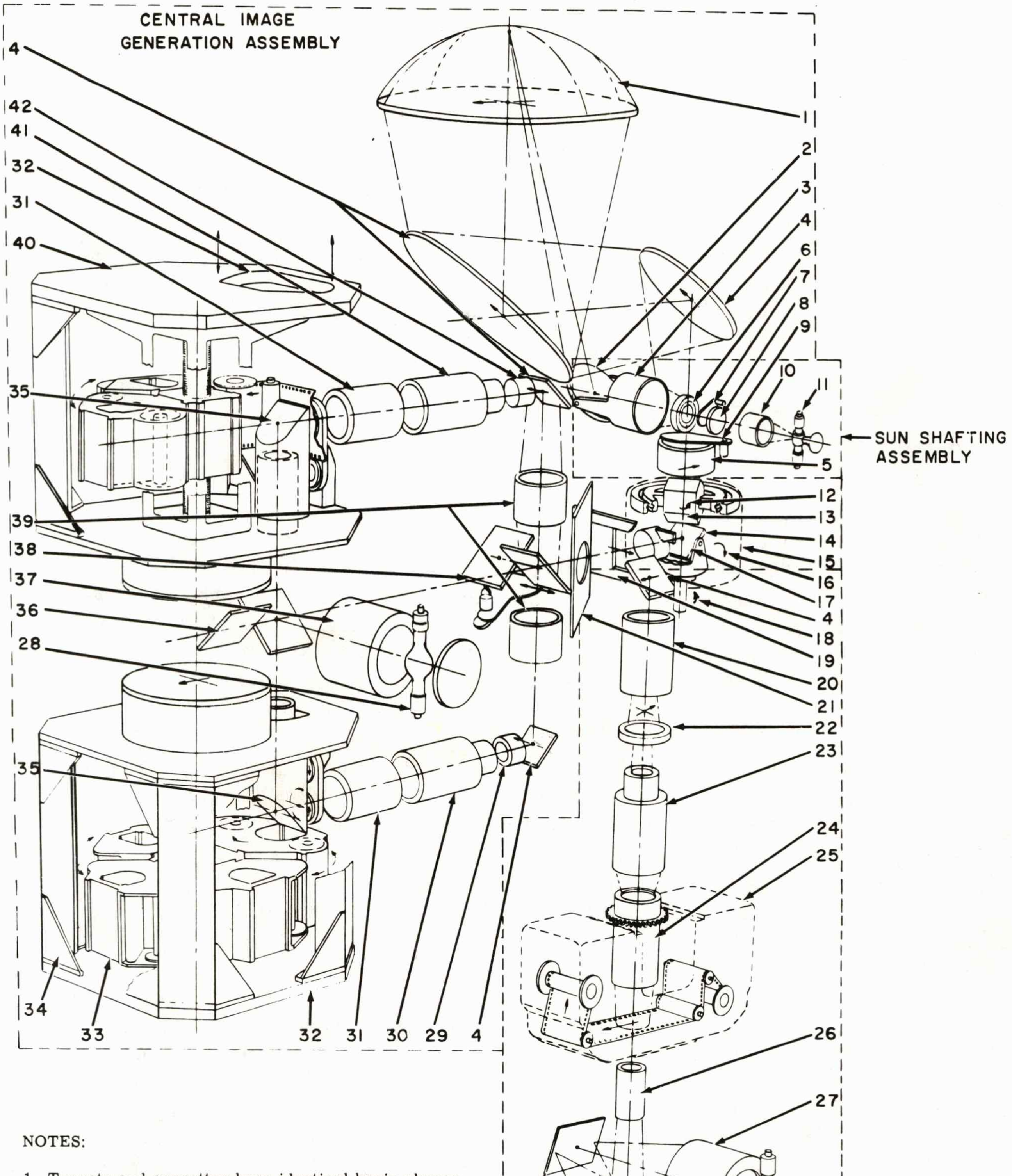


Figure 1-68. Illumination of the Celestial Sphere

unwinding of the tape upon the spindle. This increases or decreases the diameter of the occultation shadow as may be required for the generation of occultation discs of varying diameter. This simulates the varying diameter of the silhouette of the earth, moon, or target vehicle when located at varying distances from the command module.

1-318. MISSION EFFECTS PROJECTOR (MEP).

1-319. The function of the MEP (see figure 1-69) is to provide earth scenes at the four window visual displays and at the simulated telescope visual display. A secondary function of the MEP is to provide sun image generation at the four window displays. Solar simulation is the only feature present in the window MEP units that is not duplicated in the telescope MEP unit. Simulation of sunlighting on the telescope optics is provided by means of a lamp. The accuracy requirements of the telescope MEP are much more severe than those required for the window MEP's because the telescope is used for guidance and navigational training.



NOTES:

1. Turrets and cassettes have identical basic shapes. No left and right hand constructions are involved.

2. Trans-boundary effects.

3. Arrows denote direction of rotation.

Figure 1-69. Mission Effects Projector Schematic

Reference List for 1-69

1. Screen
2. Solar Scanning Mirror
3. Solar Projection Lens
4. Relay Mirror
5. Projection Lens
6. Solar Brightness Control
7. Solar Occultation Shutter
8. Solar Field Stop
9. Blanking Shutter
10. Solar Condenser Lens
11. Solar Xenon Arc Lamp
12. Roll Axis
13. Derotation Prism
14. Pitch-Yaw Mirror
15. Scanning System Assembly
16. Yaw Axis
17. Collimator Lens
18. Pitch Axis
19. Day-Night Terminator
20. Varifocal Lens Assembly No. 3 (See Note 2) (1:4:1)
21. Ring Mirror "Extended Off Course"
22. Horizon Mask
23. Varifocal Lens No. 2 (4:1) (See Note 2)
24. Collimating Lens (See Note 2)
25. Cassette (See Note 2)
26. Illumination Varifocal No. 1 (See Note 2)
27. Condenser Assembly (See Note 2)
28. Illumination Source (Hg - Xe Arc) Film Strip (See Note 2)
29. Varifocal Field Lens No. 1
30. Varifocal Lens No. 1 and Iris Drive Assembly
31. Relay Lens No. 1
32. Cassette Loading and Adjustment Opening
33. Removable Film Cassette-Typical
34. Turret No. 1 (Cassettes 1A, 1B, 1C, 1D) (See Note 1)
35. Varifocal Assembly Film Illumination
36. Quick Dissolve Film Illumination
37. Condenser Film Illumination
38. Quick Dissolve Project Output
39. Relay Lens No. 2
40. Turret No. 2 (Cassettes 2A, 2B, 2C, 2D) See Note 1)
41. Varifocal Lens No. 2 and Iris Drive Assembly
42. Varifocal Field Lens No. 2

1-320. The view at the rear projection screen of any MEP depends on the position and attitude vectors of the window associated with that MEP unit. (The telescope may be considered as just another window whose associated axis system has variable direction cosines.) The optical axis of each MEP is aligned with the optical axis of the MEP's associated window; or in the case of the telescope MEP, the optical MEP axis is aligned with the optical telescope axis.

1-321. Whenever any portion of the earth is within the field-of-view of any of the four windows or the scanning telescope, an appropriate earth scene is generated by the MEP. The MEP unit projects the appropriate scene on its screen; the image is then transferred to the window via the infinity image system (IIS) in such a way that the light rays are made parallel. This places the image at optical infinity when viewed through a window (or telescope). The IIS also combines the various images presented, i.e., MEP image and Starfield image and, at the R&D window, the target vehicle model image.

1-322. ORBITAL FREEDOM. Orbital freedom (drift from the actual orbital course) is provided to the astronaut to simulate the spacecraft drifting from the pre-planned orbital path. The system simulates drift of plus or minus 400 nautical miles at an orbit altitude of 100 nautical miles, and plus or minus 500 nautical miles at an orbit altitude of 215 nautical miles. Drift for any other altitude is provided at a rate proportional to the 100 and 215 nautical mile orbits. If the astronaut allows the spacecraft to drift past the off-course limit, the earth presentation is gradually replaced by solid moving cloud cover.

1-323. The off-course effect is simulated by moving the earth film cassette up and down on its ball screw. Extended off-course (solid moving cloud cover) is simulated by moving the cloud cover ring mirror.

1-324. The off-course I servo system supplies data to turret I and operates in the following manner. When the astronaut starts to drift from the pre-planned orbital course, the computers send an error signal (minus 10 volts dc to plus 10 volts dc) to a 400-cycle modulator. The 400-cycle modulated output signal is amplified sufficiently by a preamplifier and a power amplifier to drive the servo motor attached to the turret I ball screw. A mechanical connection between the servo motor and a plus or minus ten volts dc follow-up potentiometer set up the feedback circuit. The voltage at the follow-up potentiometer is opposite in polarity to the input voltage. When the servo drives so that the input signal is equal and opposite to the follow-up potentiometer voltage, the system sees a null and the servo stops. The extended off-course servo system supplies data to the cloud cover ring mirror. Operation of this servo system is the same as for the off-course I system except that the servo drives a gear which moves the ring mirror.

1-325. MISSION FILM LAMP. The mission film lamp assembly provides the illumination required to display the earth/moon films located in turret I or turret II. This assembly consists basically of a high intensity light source and a condenser lens. Light rays from the mission film lamp are passed through the condenser lens. The condenser lens focuses the light rays into a condensed beam of light of sufficient intensity to illuminate the films, and directs this light to the quick dissolve mirrors.

1-326. QUICK DISSOLVE I. The quick dissolve I mirror assembly directs the light beam from the mission film lamp into turret I or into turret II. The quick dissolve I mirror assembly consists of two mirrors set at a 90-degree angle from each other. The mirrors are mounted on a common shaft and slide back and forth to transfer the light path from one turret to the other.

1-327. TURRET I. The turret I assembly is comprised of the following subassemblies:

a. Earth/Moon Illumination I. The earth/moon illumination I subassembly contains a varifocal lens that controls the diameter of the light beam being projected onto the film surface. The area of the film viewed at the SCM windows depicts a 90-degree from nadir field-of-view. As the SCM increases in altitude, the actual area (of the earth or moon) covered by the 90-degree field-of-view increases. When this situation occurs, the light beam diameter must also increase to cover the expanded viewing area on the film. Conversely, as the SCM decreases in altitude, the actual area (of the earth or moon) covered by the 90-degree field-of-view decreases; and the diameter of the light beam decreases. The varifocal lens changes focus (proportional to altitude) to compensate for the different densities of light which are dominant during any diameter change in the light beam.

b. Cassette. Each turret in the MEP has provisions for four cassettes. These cassettes are identical and interchangeable. Each cassette holds film

used for scene simulation. The cassettes and the turrets are replaceable without readjustment of the image generation assembly optics. Transverse (off-course) motion of the four film cassettes is accomplished simultaneously via control of the respective turret. The control also provides for complete removal of each cassette assembly from the viewing gate of the turret. This is required for the re-indexing of the turret to allow positioning of another cassette in the gate. Each turret is capable of being driven separately, both transversely and rotationally (such as for indexing another cassette for viewing). A cassette is selected for viewing by rotating the turret with a turret indexing servo until the respective cassette is positioned directly under the varifocal assembly film illumination unit. The cassettes in the turret are then driven up until the film in the selected cassette is in position for viewing.

1-328. The earth orbital film is driven so that the point on the film which corresponds to the instantaneous nadir position is centered with respect to the MEP projection system. In order to center the nadir point, servos drive the film in the direction of the film centerline and also in a direction perpendicular to the film centerline. These servos are referred to as the orbital film drive and the orbital film "off-course" drive. Since there are two turrets in a given MEP unit, there are two sets of these servos in each MEP unit. Both nadir centering servos have fast and normal drive capability. The fast drive mode of the orbital film off-course servo is the same as the fast drive mode of the extended range off-course servo.

1-329. RANGE I. The range I system consists of a servo driven varifocal lens, which is used to simulate increases and decreases in orbital altitude. As the simulated range increases or decreases, the range I varifocal lens assembly zooms in or out to magnify or reduce the film image. This lens works in conjunction with the illumination I varifocal lens to simulate the ranges.

1-330. QUICK DISSOLVE II. The quick dissolve II mirror assembly is identical to the quick dissolve I. This assembly is physically connected to the quick dissolve I and operates at the same time. Quick dissolve II reflects the projection from either turret I or turret II (depending on position of the quick dissolve assemblies) through the extended off-course ring mirror.

1-331. TURRET II. The operation of the turret II assembly is exactly the same as for turret I. This turret is in the viewing position during the time that turret I is in use and film projection changes are simply a matter of operating the quick dissolve assemblies.

1-332. EXTENDED OFF-COURSE RING MIRROR. The extended off-course ring mirror is placed near the day-night terminator plane so that the peripheral (cloud) area image will be added around the central area image. This limits the area of the MEP screen onto which the central image may be projected. The ring mirror has no effect on central image generation until the

ground track image area film being viewed nears the edge of the film. As the central image area being projected overlaps the inside edge of the ring mirror, that portion of the central image in the overlap areas is blanked out, so that only cloud scenes appear. Because of the shape, size, and sharpness of the edge of the overlap area, vignetting (merging) of the cloud scenes and central image take place over an angle of at least two degrees. The ring mirror also prevents the film sprocket holes from being projected onto the MEP screen.

1-333. The extended range off-course ring mirror is only driven when the 90 degree earth scene about nadir begins to leave the film. This happens because the command module's nadir point has been translated a sufficient distance from the film centerline. Thus, the extended range off-course mirror drive requirement commences when the 90 degree field-of-view becomes tangent to the film edge. The servo which controls extended range off-course travel has a changeable gear ratio in order to provide fast drive capability.

1-334. DAY-NIGHT TERMINATOR. The day-night terminator is a mask with dark, clear, and dark surfaces that blank out the image from the MEP screen. This simulates the change from night to day to night on the earth's surface due to the relative position of the earth and sun, and to the rotation of the earth. The rate of blanking time as it moves across the earths surface is proportional to the rate of earth rotation.

1-335. In order to have the correct angular relationship between the surface of the simulated earth scene and the day-night terminator (lines of gradually growing darkness during dusk and gradually growing light during dawn), the day-night terminator has the capability of undergoing displacements. These angular displacements are measured with respect to that position of the day-night terminator strip in which the terminator lines are perpendicular to the centerline of the film. Thus, dusk, night, and dawn may be superimposed on the earth scene with an angular orientation that corresponds to the earth's and sun's relative positions existing on the particular date of the mission.

1-336. The day-night terminator is arranged so that it will occult all or part of the image toward one limb of the earth. The terminator makes the earth image appear light to represent day, and appear dark to represent night. Both the angle and timing of the terminator are servo controlled. The night scenes of earth are representative of the moonlight scenes. The lighting level is controlled so that cloud and water masses are visible after 10 minutes of dark adaption. Both the angle and timing of the terminator are servo controlled.

1-337. Day-night terminator strip translation is controlled by a servo which is called the day-night terminator time drive. The day-night terminator strip gives the special effects of dusk, night, and dawn. This is accomplished by means of a semi-transparent material which varies in density. This gives

the effect of increasing darkness during dusk, uniform darkness during night, and decreasing darkness during dawn. The day-night terminator time drive has three modes of operation: normal drive, fast drive, and rapid reset. In the rapid reset mode, the day-night terminator time drive is generated once the day-night terminator strip has been driven to its far end.

1-338. The angle the day-night terminator makes with respect to the film centerline is controlled by the day-night terminator angular position drive, and varies very slowly. Therefore, this servo is a single-speed servo. The angular orientation of the day-night terminator can be varied as much as plus or minus 90 degrees from an initially aligned orientation with respect to the film centerline.

1-339. SCANNING ASSEMBLY. The scanning assembly provides simulation of attitude changes of the spacecraft by moving the image on the MEP screen along the roll, pitch, and yaw axes of the respective window (or telescope) reference frames. The optics of the scanning assembly (see figure 1-70) include a scanning mirror and a double-dove derotation prism. The image input and output of the scanning assembly is provided by a collimation lens and projection lens, respectively. These two lenses are designed so that "collimated ray space" exists between them. The scanning mirror (located next to the collimating lens) has two degrees of freedom and can deflect its image input so that any portion of the film image area may be centered on the projection lens/projection screen optical axis. The deflection can be such that none of central film image area is picked up by the projecting lens and focused on the screen. The pitch-yaw scanning mirror deflects the nadir image so that the line-of-sight to the nadir image on the rear projection screen has the same direction cosines, with respect to the window frame-of-reference, as are dictated by the simulated spacecraft attitude. The double-dove image derotation prism, located next to the projection lens, compensates for image roll introduced by the deflection mirror and provides simulation of the "roll" of the spacecraft about the optical axis of the window.

1-340. The pitch and yaw axes of the pitch-yaw mirror and the axis of the double-dove prism are all driven by two-speed servo systems. The coarse resolvers are designed so that their angular deflection is exactly the same as the angular deflection of the image at the screen. In the case of the pitch mirror, one degree of mirror rotation causes five degrees of image rotation. There is a 5:1 gear ratio between the pitch mirror and its associated coarse resolver. In the case of the yaw mirror, a 10:1 gear ratio between the yaw mirror and its associated coarse resolver causes 10 degrees of image rotation for each degree of mirror rotation. For the double-dove prism, a 2:1 gear ratio causes two degrees of image rotation for each degree of prism rotation. The fine resolvers associated with the pitch and yaw mirror are geared up eight times with respect to their associated fine resolvers. The fine resolver associated with the double-dove prism is geared down 16 times with respect to its associated coarse resolver.

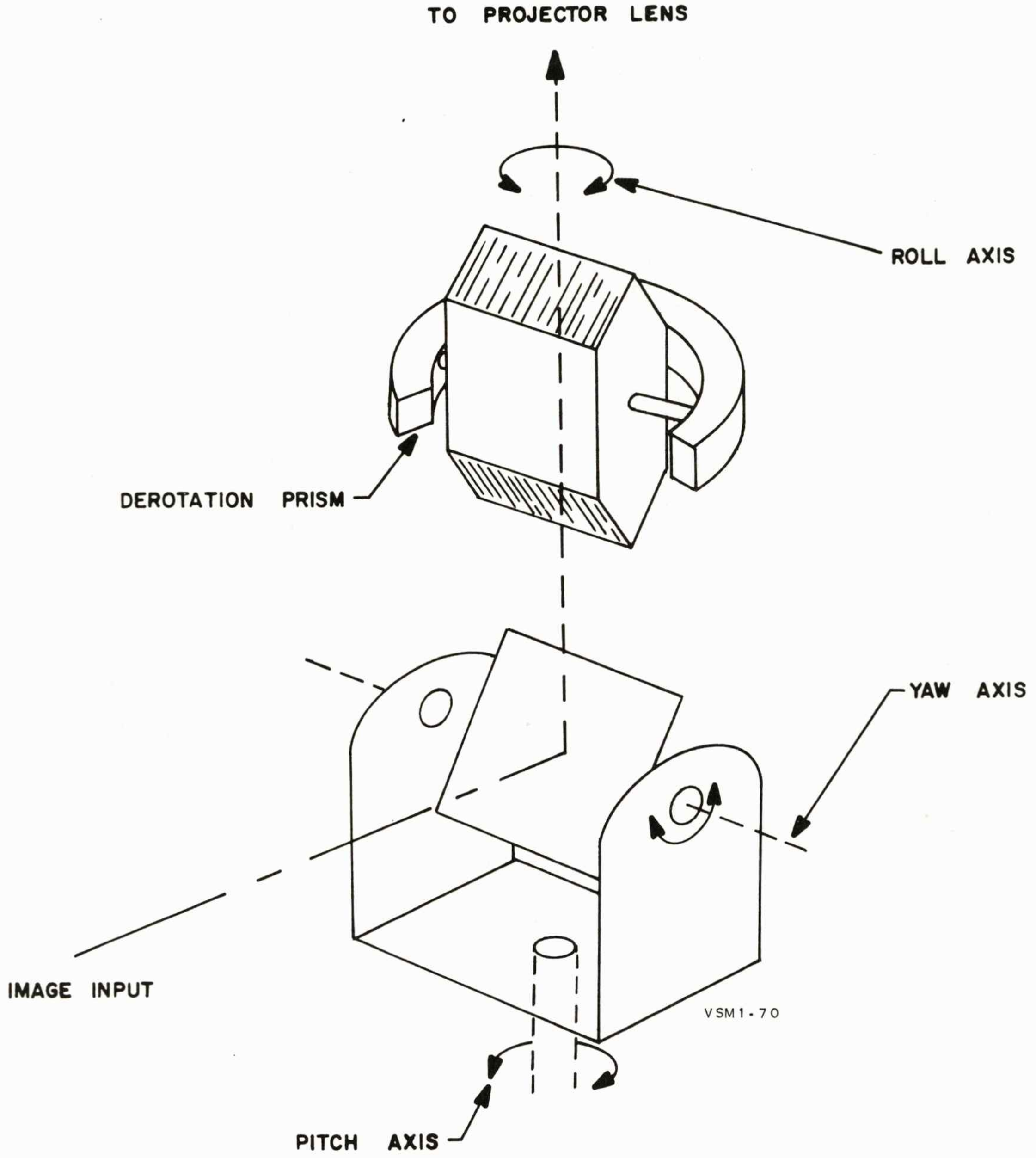
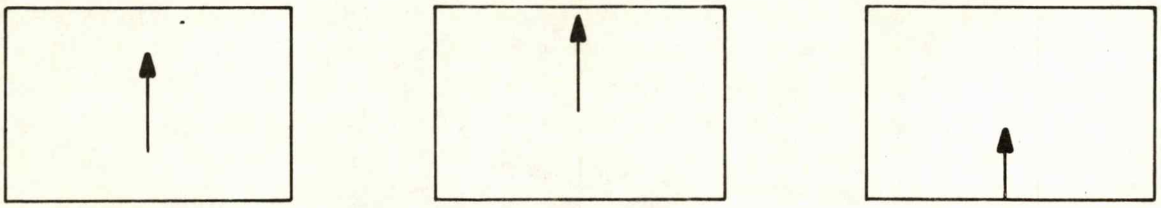


Figure 1-70. Scanning Mirror Assembly

1-341. Figure 1-71 shows the motions simulated as viewed from a given window (or telescope). In (a) of this figure the film is at the 90 degree nadir position. (That is, the line-of-sight from the window is centered on the ground track.) Pitch motion (relative to the window optical reference frame) is simulated by moving the image up (pitch down) or down (pitch up) (see b and c in figure 1-71); yaw motion is simulated by moving the image left (yaw right) or right (yaw left) (see d and e in figure 1-71); roll motion is simulated by rotating the image (see f and g in figure 1-71). The layout of the scanning assembly is shown in figure 1-70, with the pitch, yaw, and roll axes indicated.



ROLL, PITCH, YAW = 0°
(FILM AT 90° NADIR
POSITION)

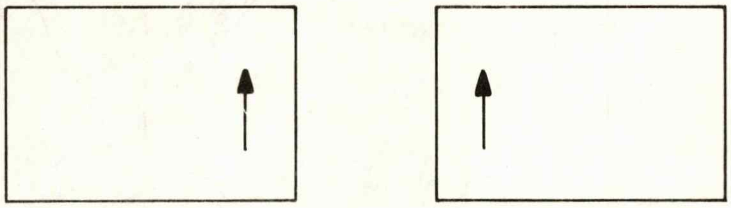
(A)

ROLL, YAW = 0°
PITCH DOWN (−)
SIMULATED

(B)

ROLL, YAW = 0
PITCH UP (+)
SIMULATED

(C)

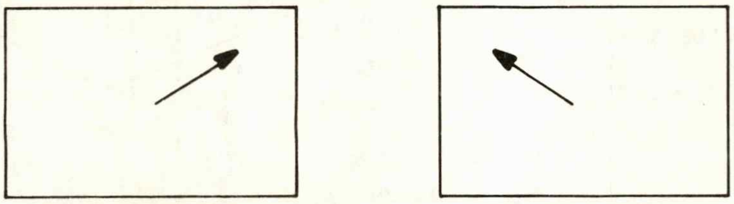


ROLL, PITCH = 0
YAW LEFT (-)
SIMULATION

(D)

ROLL, PITCH = 0
YAW RIGHT (+)
SIMULATION

(E)



PITCH, YAW = 0
ROLL LEFT (-)
SIMULATION

(F)

PITCH, YAW = 0
ROLL RIGHT (+)
SIMULATION

(G)

VSM1-71

Figure 1-71. Image Motion Due to Scanning Assembly Rotations

1-342. MEP SCREEN AND PROJECTION SYSTEM. The output of the scanning assembly is projected onto the MEP screen via the projection lens and two relay mirrors. The image developed by the MEP is projected on a rear projection screen of 13.58 inches radius and subtends 110 degrees. The screen has a radiation characteristic so that with the angle accepted by the full pupil and field-of-view of the infinity image system, the minimum intensity is not less than 50 percent of the maximum intensity. The image on the MEP screen appears correct when viewed from the center of the radius of the screen.

1-343. A constant output screen illumination for orbital missions is maintained at the output of the MEP by illuminating the portion of the film that is displayed on the output screen as a 90 degree image. The area of film illuminated is always a 90 degree view of the earth centered on the nadir and is, therefore, dependent on the film scale, simulated altitude, and degree of spherical distortion introduced.

1-344. A 2500-watt mercury Xenon arc lamp is used; however, it is possible to reduce the power input to a value below 2500 watts to increase the life of the lamp and stay within the energy absorbtion limits of the film. The amount of infra-red and ultra-violet energy which reaches the film is reduced as much as possible by the use of dichroic surfaces on the condensing system mirrors.

1-345. BLANKING SHUTTER. In order to prevent the rear projection screen from being illuminated when a simulated mission is operating in a region where there are no filmed scenes, a blanking shutter is activated. This blanking shutter is located in front of the projection lens and is driven by a solenoid.

1-346. TRANSBOUNDARY (CLOUD COVER) ASSEMBLY. An optical schematic of the transboundary assembly, which provides visual simulation of the cloud cover about the earth, is shown in figure 1-72. The cloud scenes are on one film contained in the transboundary cassette. The film provides solid moving cloud scenes through one and one-half rotations of the earth. The optical path for an image on the film passes through a collimating lens, a varifocal (zoom 4:1) lens, the horizon mask, the second varifocal lens (1:4:1), and a relay mirror. It is then projected onto the extended off-course ring mirror. This ring mirror is positioned so that the incoming image from the central image generation assembly is reflected from the surface area of the mirror into the scanning assembly. The ring mirror is controlled to substitute a cloud image from the peripheral cloud image path for a portion (or all) of the central area image if the mission maneuvers result in a spacecraft attitude position outside the range of the film ground track.

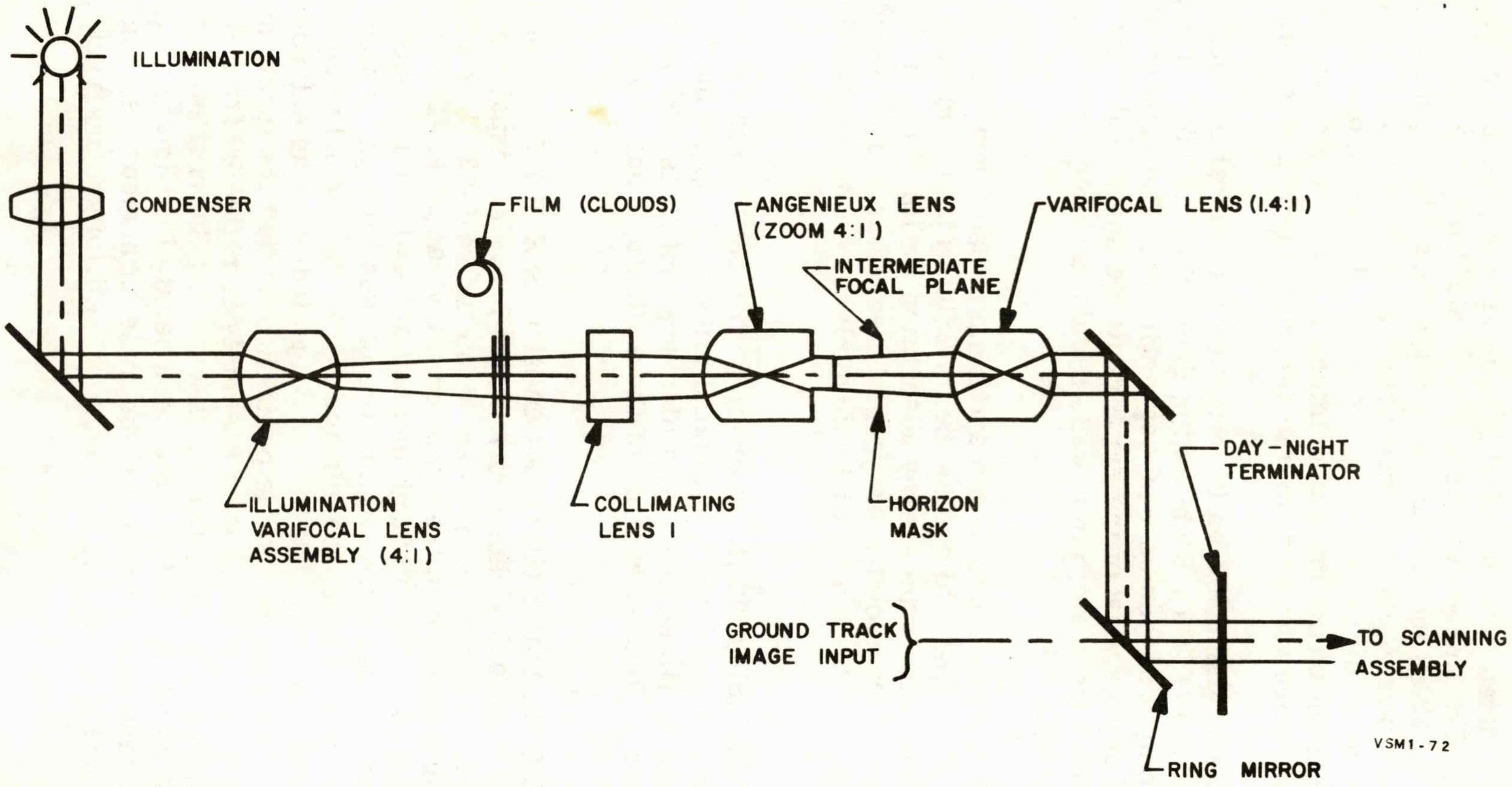


Figure 1-72. Transboundary (Cloud Cover) Assembly Optics

NOTE

A 4:1 varifocal lens and a 1.4:1 varifocal lens are used together to give a magnification range of 5.6:1. This is used to simulate 10:1 altitude variation (100 to 1000 nm).

1-347. Transboundary Varifocal Lens Assemblies. In order to give the transboundary peripheral area display the proper appearance as a function of altitude, image magnification must be controlled. This control is accomplished by using a varifocal lens in the same manner as for the central image varifocal lens. Two-speed operation of the transboundary varifocal lens is provided. The area of the transboundary effects film is viewed as a function of altitude. In order to keep the area being viewed under constant illumination, a varifocal lens is used to control the illumination of the transboundary effects film. The servo driving the illumination varifocal has both a normal drive and fast drive capability. The diameter of the image representing the limb-to-limb (horizon-to-horizon) of the earth at the day-night terminator focal plane is controlled by the limb diameter control iris (at the intermediate focal plane) and the 1.4:1 varifocal lens. The limb-to-limb image diameter at the day-night terminator plane corresponds to a 100 to 1425 nautical mile range. The scale of the image at the limb diameter (intermediate) focal plane can be controlled over a 4:1 range via the varifocal lens. The film image scale is the same for all ranges. The change of scale of the clouds is limited to that provided by the product of the range of the two varifocal lens assemblies.

1-348. Transboundary Film Drives. The transboundary peripheral area display must also have the appearance of relative motion with respect to the SCM. This appearance of relative motion is provided by driving the peripheral area cassette at a speed that corresponds to the simulated motion of the instantaneous nadir point with respect to the surface of the earth. The peripheral area cassette contains film to provide for one and one-half earth rotations. When the supply of peripheral area film is depleted, the peripheral area cassette is reset. Both fast and normal drive speed is provided by the same type of mechanism used to control the central image illumination varifocal servos.

1-349. The reference direction within a given MEP unit is the film centerline. In general, the velocity of the nadir point with respect to the earth's surface makes some angle with respect to the film centerline. Therefore, the relative motion of the peripheral display must appear at some angle with respect to the projected film centerline. This angular motion is provided by the peripheral area cassette angular position servo.

1-350. The peripheral (cloud) film position drive is obtained by integrating the ground speed to assure synchronization of the peripheral and central area images (for all altitudes) at the day-night terminator plane. The peripheral area range is oriented by rotation of the film cassette mounting within one degree of the instantaneous film drive angle of the central area film. This

action provides for angular alignment of the images. The limb, peripheral range, and peripheral illumination varifocal drives are functions of range, and are stored in the computer complex.

1-351. The maximum and minimum diameters of the cloud film image are 110 mm and 27.5 mm, respectively. Since these diameters do not permit lateral scanning of the film over the same range in which the central area film is scanned, the peripheral area film cassette drive is modified to provide for angular motion, rather than linear motion, across the screen.

1-352. The optics of the transboundary assembly make the aerial image of a flat film at the limb control image plane appear spherical at the day-night terminator plane. This arrangement provides the required divergency and rearward convergence of the image, independent of the altitude range simulated.

1-353. Horizon Mask. The horizon effect of the earth is provided by the horizon varifocal lens and the horizon mask. The cloud scenes viewed are projected onto the MEP screen via the horizon mask varifocal, which controls the diameter of the cloud scene image. The angular limb subtending the earth is a function of the SCM's altitude. The correct angular subtending within a given MEP, is achieved by driving the horizon mask varifocal as a function of altitude. This horizon mask varifocal varies the projected diameter of the horizon mask on the MEP screen. The horizon mask varifocal drive has both fast and normal drive speed capability. Sunrise and sunset are simulated by expanding the mask to expose two arcs of colored material. These colored bands are exposed by means of a diaphragm drive whenever the total projected scene passes a day-night interface. The colored bands are exposed for a nominal 30 second period at this time. This diaphragm drive is called the sunrise annuli drive. The colored bands are illuminated by the peripheral area illumination lamp via the associated film and the horizon varifocal lens. The colored bands are both illuminated at the same time; however, only one will be visible since the undesired one will be occulted by the day-night terminator. The angle of the center of the sunrise and sunset arcs can be adjusted to meet the requirements of a given mission.

1-354. Operation of the horizon mask iris is servo controlled to allow simulation of either sunrise or sunset by controlling the time the iris is expanded. The day-night terminator drive and the sunrise-sunset iris position drive are positioned as a function of the angle between the position vector to the spacecraft, the position vector to the sun, and the altitude. The angle of the day-night terminator is servo-positioned in accordance with the specific orbit inclination and the sun position; however, the angle of the sunrise is manually adjusted to correspond to a given ground track. Only a manual adjustment of the sunrise angle is required due to the low accuracy requirements of its use only on earth scenes.

1-355. Blanking Shutter. Each MEP unit has the capability of blanking the peripheral area scene whenever the SCM's altitude is greater than 1000 nautical miles. Above a 1000-nautical mile altitude, the entire earth is to be obtained from a single film located in one of the turrets as opposed to being composed of a peripheral area scene superimposed on an earth surface scene. The peripheral area scene blanking shutter is located in the optical path between the collimating lens and the Angenieux lens.

1-356. SOLAR IMAGE PROJECTOR. (See figure 1-73.) The sun-shafting assembly provides simulation of sun effects on the MEP screen. Although the sun-shafting assembly is physically packaged within the window MEPs (solar simulation for the telescope is not provided by its MEP unit), it is not a part of and does not have an interface with the central image generation assembly or the transboundary assembly. The sun-shafting assembly output is projected directly onto the MEP output screen.

1-357. The major components of the sun-shafting assembly include a high intensity lamp, a projection lens, and a scanning mirror mounted in a gimbal assembly providing two degrees-of-freedom (pitch and yaw). Operation of the scanning mirror is similar to that described for the scanning mirror in the central image generation scanning assembly; however, roll motion is not simulated since the sun is essentially symetrical.

1-358. The sun image at a given window consists of the projection of a fixed-diameter, pinhole source of high intensity light on the rear projection screen of the associated MEP. Because the distance from the light source to different points on the rear projection screen varies slightly, the projection of the accomplished by displacing the projection lens. A solar blanking shutter is provided to avoid reflections of strong light when the displayed sun image is outside the field-of-view of a given window.

1-359. The sun projector casts a bright circular spot, representing the scaled sun diameter, on the MEP screen 32 arc minutes (plus or minus 10 percent) in diameter. The sun image is projected from off-axis, relative to the MEP screen optical axis, and is positioned on the screen by use of a scanning mirror having two degrees of freedom. A brightness of 500 foot-lamberts or more are obtained through the IIS. The image is approximately circular in shape with the ratio of the maximum to minimum chord dimension less than the ratio 4:3.

1-360. RENDEZVOUS IMAGE GENERATION.

1-361. This system includes all of the equipment necessary to simulate the rendezvous and docking maneuvers as seen by an astronaut during an Apollo mission to the moon. Although the lunar excursion module (LEM) is not used in the initial Apollo training mission, the events which take place for

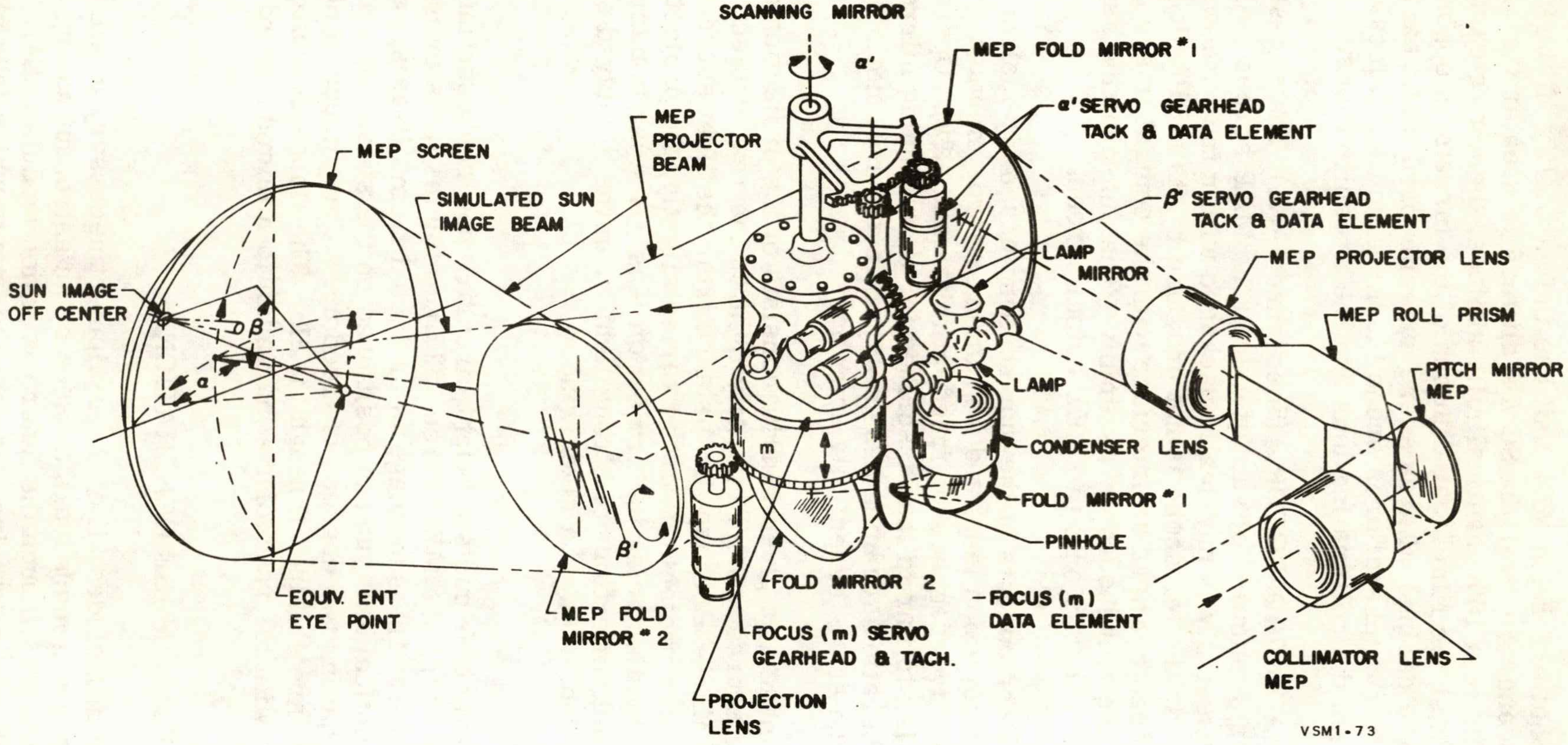


Figure 1-73. Solar Image Projector Layout

a complete mission are described in these paragraphs. A pictorial illustration of a complete mission is also included which lists the various phases of the mission along with the automatic and manual operations which take place. The mission stages described in these paragraphs are not applicable to every airframe, however, each airframe includes various portions of the referenced operations.

1-362. During rendezvous and docking procedures, and at anytime when the target vehicle is viewed, the appropriate display is transmitted to the astronaut via closed circuit television and an optical path. The image viewed is generated either from a film slide pickup or from the model, depending upon the particular phase of the mission (see figure 1-74). The image is displayed in its proper orientation relative to the command module and is illuminated in accordance with the relative position of the sun or moon.

1-363. The target model is first viewed shortly after the trans-lunar thrust during the command module transposition mode. While the transposition phase and rendezvous maneuvers are being accomplished, two television pick-up units mounted on a movable carriage view the model. Relative distance and motion are compensated for by computer controlled servo drives.

1-364. When the docked position is reached, a slight jar might be noticed in the operational spacecraft. (Fourteen inches is maximum off-alignment in the operational spacecraft. In the model it is three-fourths of an inch.) At this instant an electronic switching unit shifts the television pick-up from the model-viewing camera to two slide viewing television camera. A 35 mm film slide of the docked vehicle is then displayed on the CRT screen for viewing during the trans-lunar coast phase of the mission. While this phase of the mission is in progress, a section of the model is removed.

1-365. The lunar parking orbit is reached, simultaneously with the separation of the LEM from the simulated command module, then the scene is shifted back to the model (LEM without the S-IVB). At this time, the movable camera carriage assembly moves away from the model (under computer control) up to a simulated distance of 150 feet. In conjunction with the camera carriage movement, the CRT face in the optical path moves toward the infinity image plane. As the CRT moves, the image finally appears at infinity (depth perception no longer a function). Relative movement of the two vehicles is accomplished by the various servo drives of both the camera carriage assembly and the model, and by raster decentering. From the apparent distance of 150 feet to 10,000 feet, a servo causes the raster on the CRT to shrink, thus making the LEM image appear to be moving away toward its landing on the moon.

1-366. When a distance of 10,000 feet is reached, the LEM is no longer visible and a flashing light (the LEM beacon) is viewed. This is accomplished by switching from the camera to an electronic beacon light generator for the

1. Transposition Mode (Model Viewed)
2. Docking procedure accomplished (Switch to LEM S-IVB film slide pickup)
3. S-IVB section of model removed
4. Switch to model; LEM separates from Command Module (Camera moves away from model)
5. LEM disappears (Raster shrinks)
6. Beacon disappears (Video input removed)
7. LEM landing (descent stage removed from model)
8. Beacon appears (Video input restored)
9. LEM appears (Raster expands)
10. Rendezvous and Docking with LEM (Camera moves in); Switch to Film Slide (LEM ascent stage in docked position)
11. Switch to model; LEM ascent stage jettisoned (Camera moves away from model)
12. LEM disappears (Raster shrinks)
13. Beacon disappears
14. Video input removed
15. Starfield and MEP inputs throughout remainder of mission (LEM left in Lunar Orbit)

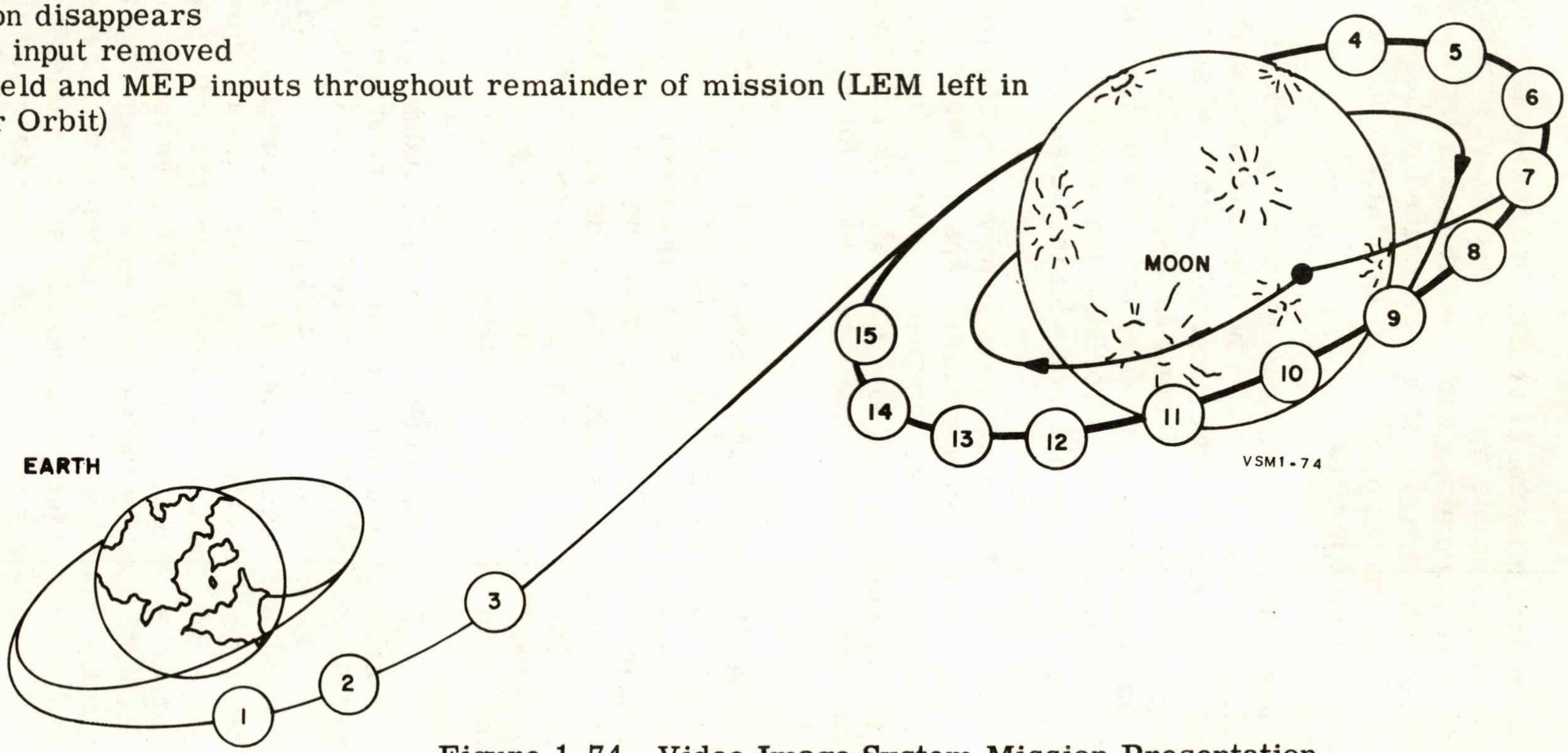


Figure 1-74. Video Image System Mission Presentation

input to the display circuitry. The beacon light can be seen to a range of 20 nautical miles, at which time it disappears from view. Normal stars, moon, etc., are viewed during all phases of the mission, including the rendezvous and docking phases.

1-367. Prior to rendezvous with the ascent stage of the LEM (the descent stage having been manually removed), the reverse of the preceding sequence is true for the rendezvous and docking procedures. Once the docking phase is completed, a docked view of the ascent stage of the LEM is presented. (The slides are manually changed while the command module is in the lunar parking orbit.) When the LEM ascent stage is jettisoned, it will be seen to move away from the SCM in the same manner as discussed above. During the trans-earth coast, normal starfield and mission effects are presented.

1-368. RENDEZVOUS SERVO SYSTEMS. The servos employed in the image generation equipment are all position servos. The output is either a position or an angular attitude as a direct function of the signal input voltage. The servo systems are d-c systems with d-c amplifiers, d-c motors and d-c tachometers. Simplified electrical schematics of the two type of systems, linear and rotational, are shown in figure 1-75 and 1-76.

1-369. With the linear system, the summing amplifier is the comparator between input signal and actual position expressed as feedback potentiometer voltage. A rate feedback from the tachometer serves as stabilization. A power amplifier delivers the current to the motor which drives the load through the necessary gearing, and a clutch in the mechanical path protects the motor against overload. At the ends of travel, mechanical stops and, at an appropriate distance prior to the stops, limit switches are provided. The range between the limit switches is the normal operational range of the servo.

1-370. If the servo crosses a limit switch the current to the motor is removed and dynamic braking occurs. The application of a reversed current causes the return of the servo to the operational range. A graduated dial aides in initial alignment and maintenance of the servo.

1-371. The rotational system is similar to the linear system but has an additional provision for continuous rotation. This is achieved by providing two input signals and two feedback potentiometers 180 degrees displaced. Each potentiometer acts only in a 180 degree section which, when combined, provides 360 degrees. The switching is provided by a third component of the special three section potentiometers, the commutator, which could be considered a d-c resolver.

1-372. All the servos are basically defined by these two systems but differ in each case in gain, tachometer feedback, gear ratio, or type of motor-generator, according to the specific requirements.

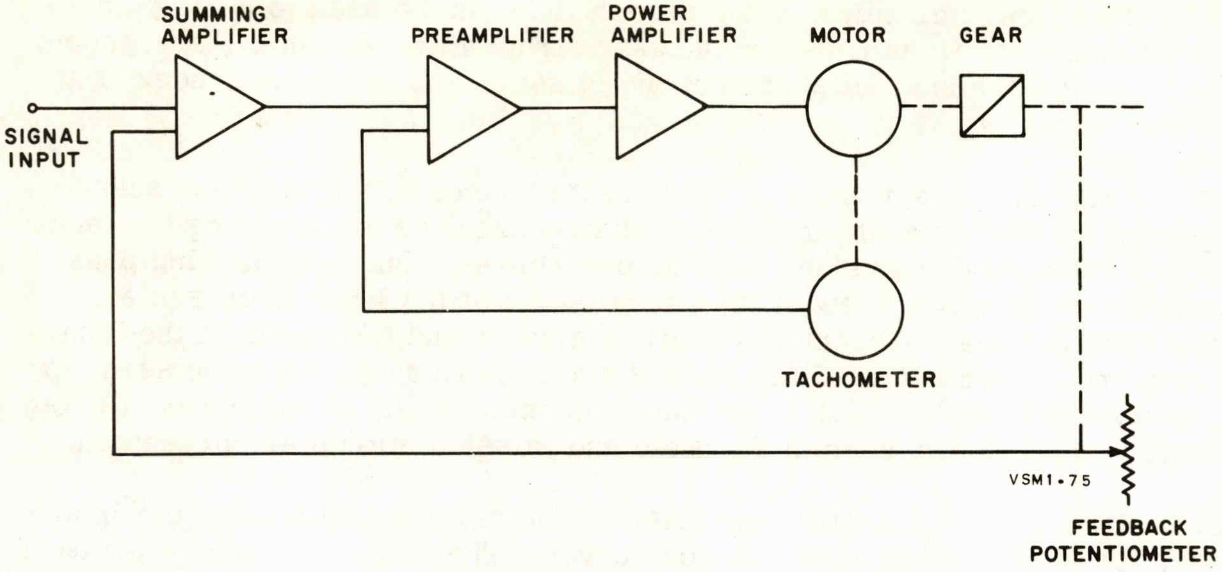


Figure 1-75. Linear Servo System-Simplified Electrical Schematic

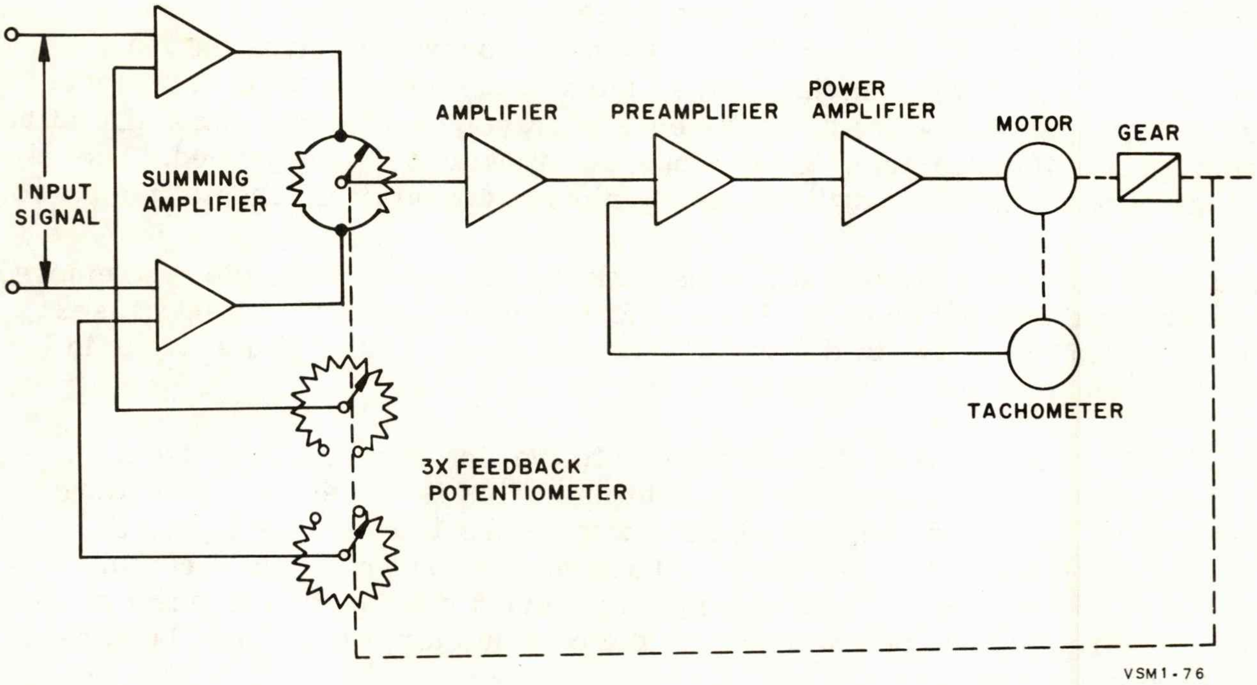


Figure 1-76. Continuous Rotation Servo-Simplified Electrical Schematic

1-373. Image Generation Equipment Servos. A total of 13 d-c servos are used in the image generation equipment with components in the servo cabinet, the model house, and the display equipment. Although the motions required for rendezvous and docking image generation have been previously discussed, they are included in table 1-32 for quick reference.

1-374. Servo System Input Signals. The servo system input signals are d-c analog voltages which vary linearly with the displacements of each motion. The range of minus 10 volts to plus 10 volts represents the excursion of each of the displacements. The d-c analog voltages representing each variable are obtained from corresponding digital voltages from the computer using digital-to-analog conversion equipment. Figure 1-177 shows a simplified block diagram of the rendezvous and docking system as related to the servos of the system.

1-375. Figure 1-78 groups the servos into their proper locations and associates them with the motion system that they drive. The number of input signals are continuous drive position servos while those requiring one input signal are limited range servos.

1-376. Servo System Performance. To insure high positioning accuracy for the servos, the power supplies used for reference voltages are slaved to the reference supplies of the electronic data conversion unit. The power supplies have a static line regulation of 0.01 percent for line changes between 105 and 130 volts.

1-377. The feedback potentiometers are precision carbon film potentiometers with 0.01 percent linearity and practically infinite resolution. The servo systems are built with precision gearing with antibacklash-gearing used on the feedback elements. Precision ball bearings are used to reduce friction and the loads are statically balanced. The amplifiers are chopper stabilized to avoid any offset voltage.

Table 1-32. Image Generation Servo Functions

Servo Name	Location	Type	Function
Sun Peripheral	Model House	Linear	Translational motion of the "sun" carriage around the periphery of the "sun" gimbal.
Range Drive	Model House	Linear	Translational motion of the camera carriage.
Focus Drive	Model House	Linear	Translational motion of the focus lens system relative to the vidicon faces.
Alpha Drive	Model House	Linear	Rotational motion of the camera in a plane perpendicular to the plane of the carriage.
Beta Drive	Model House	Linear	Rotational motion of the camera in the plane of the carriage.
CRT Drive (2)	Display	Linear	Translational motion of the image display CRT's.
Raster Size (2)	Display	Linear	These servos are used in conjunction with the image generation equipment and are driven as a function of range.
Zeta	Model House	Rotational	Rotational motion of the outer gimbal of the target model gimbal system.
X1	Model House	Rotational	Rotational motion of the intermediate gimbal of the target model gimbal system.

Table 1-32. Image Generation Servo Functions (Cont)

Servo Name	Location	Type	Function
Eta	Model House	Rotational	Rotational motion of the inner gimbal of the target model gimbal system.
Sun Rotational	Model House	Rotational	Rotational motion of the "sun" lighting system gimbal.

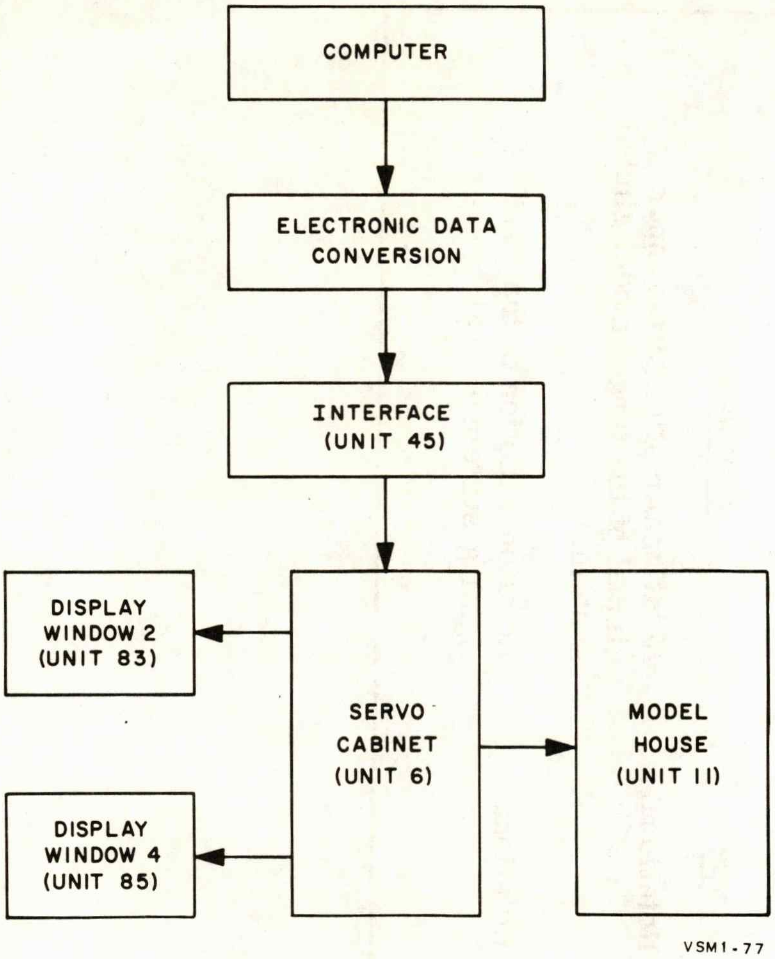


Figure 1-77. Rendezvous Servo System

1-378. POWER.

1-379. POWER DISTRIBUTION. Figures 1-79 and 1-80 are block diagrams illustrating the distribution of a a-c and d-c power to the appropriate assemblies in the guidance and navigation subsystem.

1-380. A-C Power Distribution. The a-c power utilized by the electronics cabinet, sextant, and telescope consists of 115 volt 60-cycle and 115 volt 400-cycle power.

1-381. 60-Cycle Power. The 115-volt 60-cycle power is utilized by the electronics cabinet and the sextant only. In the electronics cabinet, the 60-cycle power is used by the four d-c power supplies, the indicator lamps on the power control panel, the power failure assembly, the thermal overheat assembly, and the heater of time delay relay K4. In the sextant, 60-cycle power is used by the landmark and starfield rheostats in the power control

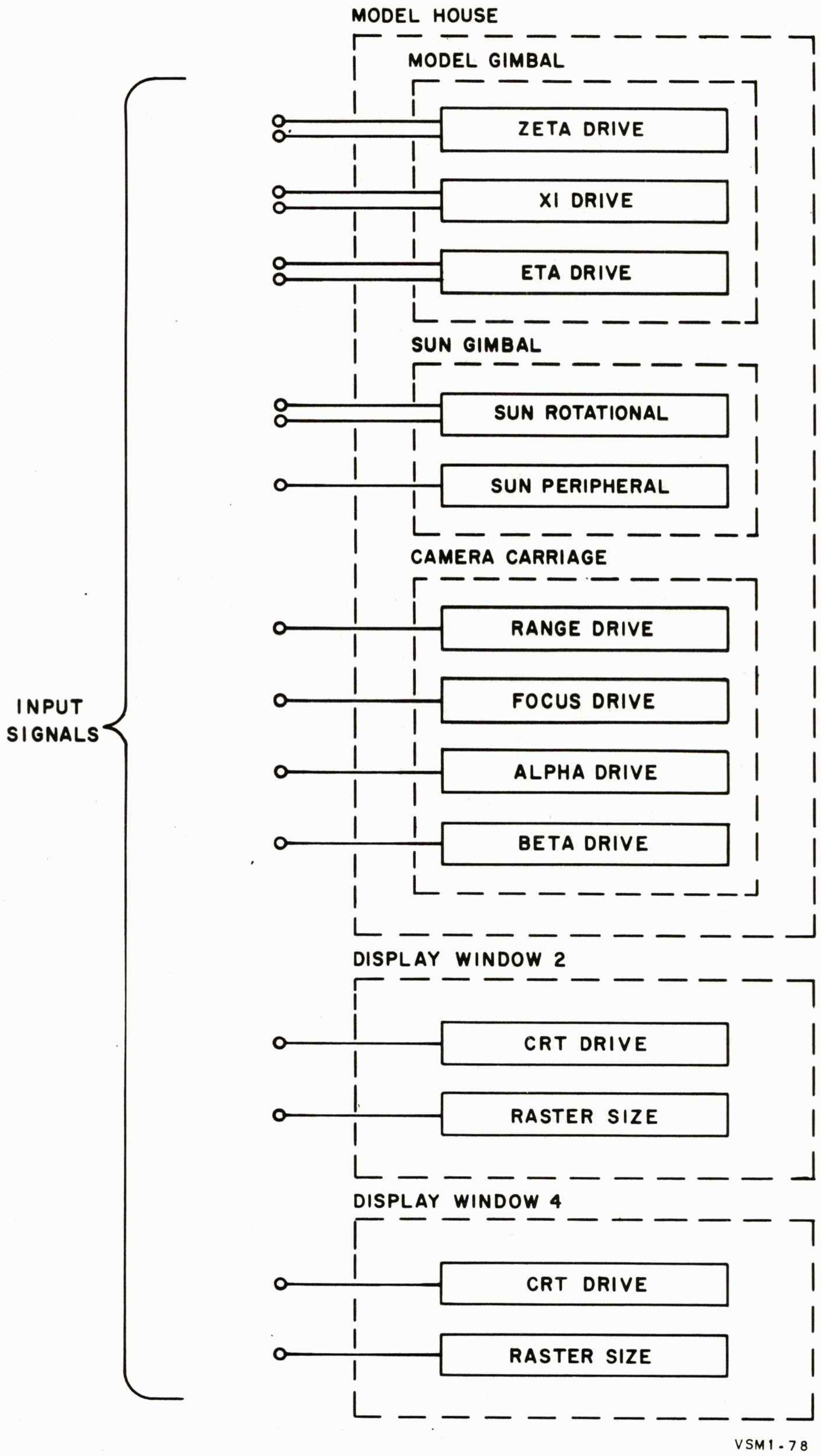


Figure 1-78. Rendezvous Servo Drive Locations

assembly (power applied directly during testing operations), the landmark and starfield projector fans, and the slosyn motor and indicator lamps associated with landmark slide actuation.

1-382. 400-Cycle Power. The 115-volt 400-cycle power is used by the electronics cabinet, the sextant, and the telescope. In all cases, 400-cycle power application is via time delay relay K4 in the power control assembly of the electronics cabinet. In the electronics cabinet, 400-cycle power is used by the demodulator transformer reference winding in each of the 10 d-c torque motor electronics assemblies, and by the transformers and test resolver director rotor windings in the test panel assembly. In the sextant, 400-cycle power is used by the a-c servo motor and tachometer reference windings and by the **CAROUSEL REMOVED** Lamp. In the telescope, 400-cycle power is used by the a-c servo motor and tachometer reference windings.

1-383. D-C Power Distribution. The four d-c power supplies produce the d-c power for assemblies in the electronics cabinet, the sextant and the telescope. Power supply number one supplies plus 28 volts dc to assemblies in the cabinet, sextant, and telescope. In the cabinet, plus 28 volts dc is reset to energize all relays in the test panel, to supply voltages for the a-c servo amplifiers, and to supply plus 28 volts dc to the low level stages of the a-c servo amplifiers via the RC filter in the power control assembly. In the telescope, plus 28 volts dc is applied to the reticle and sunshafting lamps via the telescope reticle and telescope sunshafting rheostats in the electronics cabinet. In the sextant, plus 28 volts dc is applied to the reticle and sunshafting lamps via the sextant sunshafting rheostat and the sextant reticle rheostat in the electronics cabinet. Power supply number two supplies plus 12 volts dc to the d-c torque motor electronics assemblies. Power supply number three supplies minus 12 volts dc to assemblies in the cabinet and in the sextant. In the cabinet, minus 12 volts dc is supplied to the d-c torque motor electronics assemblies. In the sextant, minus 12 volts dc is supplied to the relay control card in the carousel slide actuation electronics assembly. Power supply number four supplies plus 12 volts dc (low level) to the low level stages in the d-c torque motor electronics assemblies only.

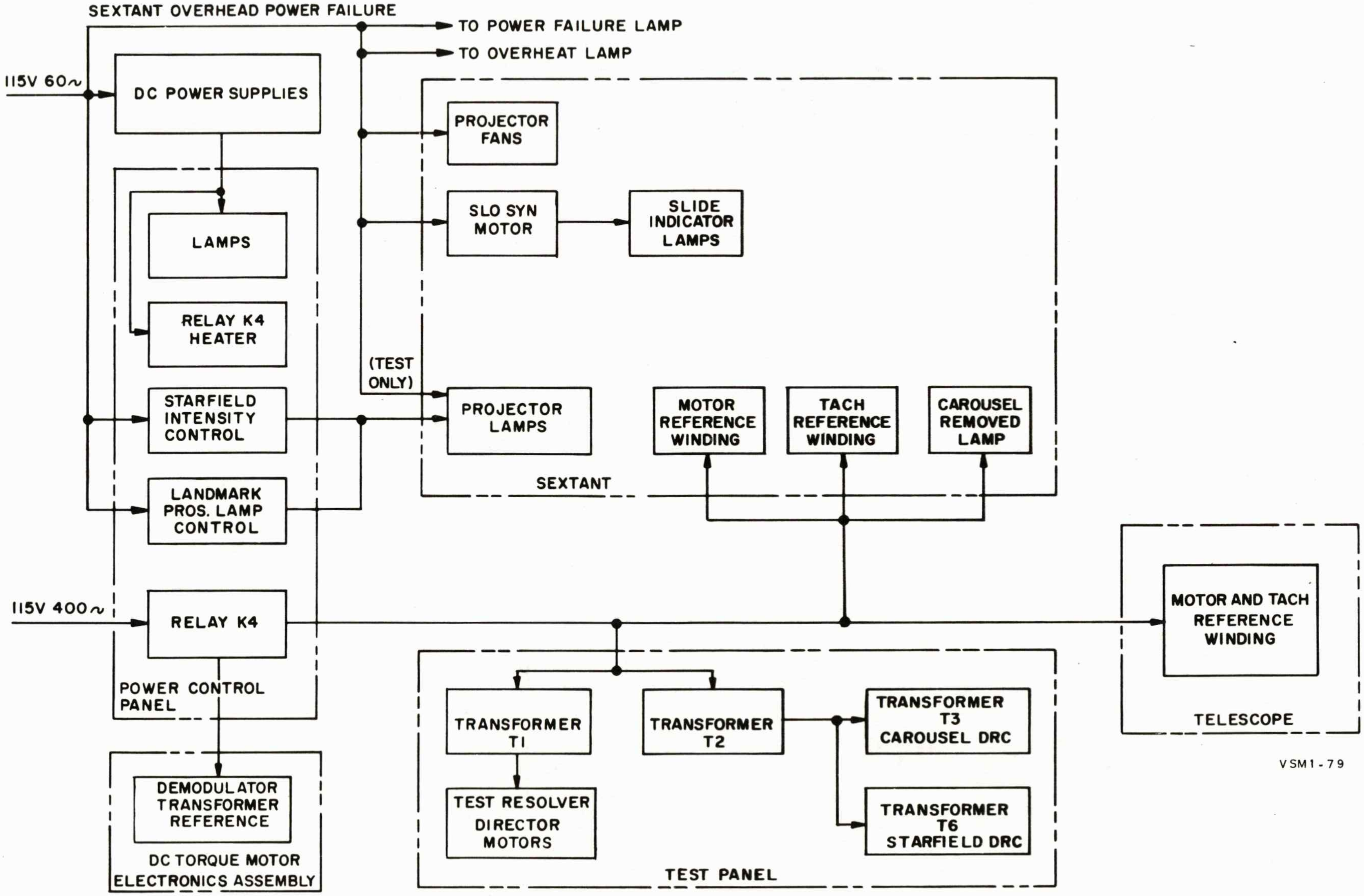


Figure 1-79. AC Power Distribution Block Diagram

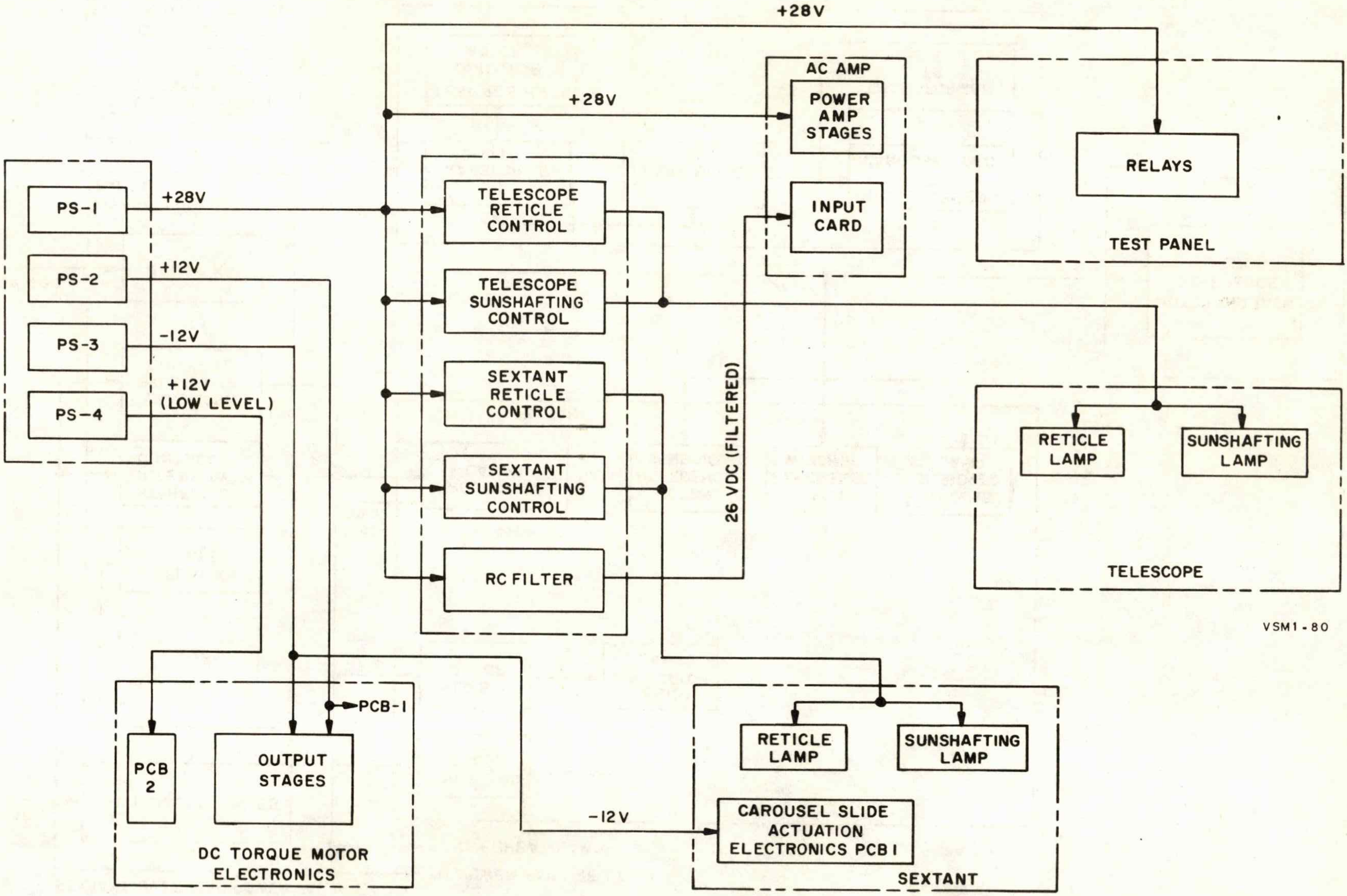


Figure 1-80. DC Power Distribution Block Diagram

SECTION II

FUNCTIONAL TEST

2-1. GENERAL.

2-2. This section contains the testing instructions to be used when a functional test of the AMS visual system is required. Two types of testing methods are provided; programmed computer testing, and manual testing. Computer testing of the system is covered in paragraph 2-13. Manual testing, covered in paragraphs 2-38 through the end of Section II, is divided into four groups; telescope, sextant, out of the window displays, and rendezvous and docking displays. Preceding the tests are turn-on and turn-off procedures and tables listing the system controls and their functions.

2-3. POWER ON AND OFF.

2-4. Turn on of the visual system is to be conducted according to table 2-1. Turn off procedures are the reverse of turn on.

Table 2-1. Visual System Power Turn On

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
	Master Visual Power			
1		32	CB4 Utility Power On-Off (Circuit Breaker)	On
2		37A1	CB15 115V Sequencing On Off (Circuit Breaker)	On
3		32	CB9 Main Power On Off (Circuit Breaker)	On
4		33	Manual Sequencing Mode	Manual
5		32	CB8 Visual Power On-Off (Circuit Breaker)	On
6		33	Visual On (Push Button)	On

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
7		37A1A2	CB11 Convenience Power To Visual Area On-Off	On
8		37A1A2	CB8 26V Indicator Lighting	On
	R and D Servos			
9		61A2A2	Convenience Protection Units 6/CB8 (Circuit Breaker)	On
10		61A2A2	Convenience Protection Units 11/CB13 (Circuit Breaker)	On
11		61A1A3	R and D Servos CB14 (Circuit Breaker)	On
12		61A1A3	R and D Servos CB15 (Circuit Breaker)	On
13			R and D Servos (Circuit Breaker)	On
14		61A2	AC Power On-Off	On

NOTE

DC output indications should be present at all power supplies. If any of the six dc power supplies fails to indicate switch AC Power to off and then to on.

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
	MEP AND Celestial Sphere			
15		61A1A2	Master Visual Power (Switch Light)	On
16		61A1A3	DBO PWR CB17 (Circuit Breaker)	On

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
17		61A1A2	MEP and Celestial Sphere Window No. 1 (Circuit Breaker)	On
18		61A1A2	MEP and Celestial Sphere Window No. 2 (Circuit Breaker)	On
19		61A1A2	MEP and Celestial Sphere Window No. 4 (Circuit Breaker)	On
20		61A1A2	MEP and Celestial Sphere Window No. 5 (Circuit Breaker)	On
21		61A1A2	MEP and Celestial (Sphere Telescope (Circuit Breaker)	On
22		61A1A3	3 Phase 60 cps Protection Window No. 1 CB 1 (Circuit Breaker)	On
23		61A1A3	3 Phas3 60cps Protection Window No. 1 CB2 (Circuit Breaker)	On
24		61A1A3	3 Phase 60 cps Protection Window No. 2 CB3 (Circuit Breaker)	On
25		61A1A3	3 Phase 3 60 cps Protection Window No. 2 CB4 (Circuit Breaker)	On
26		61A1A3	3 Phase 60 cps Protection Window No.4 CB7 (Circuit Breaker)	On

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclautre/ Description	Position
27		61A1A3	3 Phase 60cps Protection Window No. 4 CB8 (Circuit Breaker)	On
28		61A1A3	3 Phase 60 cps Protection Window No. 5 CB9 (Circuit Breaker)	On
29		61A1A3	3 Phase 60 cps Protection Window No. 5 CB10 (Circuit Breaker)	On
30		61A1A3	3 Phase 60 cps Protection Telescope CB11 (Circuit Breaker)	On
31		61A1A3		
32		61A2A2	400 cps Protection MEP and Celestial Sphere Window No. 1 CB1 (Circuit Breaker)	On
33		61A2A2	400 cps Protection MEP and Celestial Sphere Window No. 2 CB2 (Circuit Breaker)	On
34		61A2A2	400 cps Protection MEP and Celestial Sphere Window No. 4 CB4 (Circuit Breaker)	On
35		61A2A2	400 cps Protection MEP and Celestial Sphere Window No. 5 CB5 (Circuit Breaker)	On

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
36		61A2A2	400 cps Protection MEP and Celestial Sphere Telescope CB6 (Circuit Breaker)	On
37		61A2A2	Convienence Protection Units CB 16 (Circuit Breaker)	On
38		61A2A2	Convenience Protection Units CB17 (Circuit Breaker)	On
39		61A2A2	Convenience Protection Units CB18 (Circuit Breaker)	On
40		61A2A2	Convenience Protection Units CB15 (Circuit Breaker)	On
41		70A3	120/208V 60 cps 3Ø Power ON (Toggle Switch)	On
42		70A3	120/208V 60 cps 3Ø Start (Push Button)	On
43		70A21	Power On	On
44		70A22	Power On	On
45		70A3	115V 400 cps On	On
46		70A1	115V 400 cps On-Off	On
47		70A1	28VDC On-Off	On

NOTE

Repeat steps 42 through 48 at cabinet 71, 72, 73, and 10.

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
	SEXTANT AND TELESCOPE			
48		61A1A2	Master Visual Power On (Switch)	On
49		61A1A3	DBO PWR CB17 (Circuit Breaker)	On
50		61A1A2	Sextant-Telescope (Switch Light)	On
51		61A1A3	Sextant and Telscope (Three Circuit Breakers)	On
52		61A2A2	Sextant - Telescope CB7 (Circuit Breakers)	On
53		61A2A2	Conveneience Protection Units a/cB11 (Circuit Breaker)	On
54		9A1A2	10, 20, 30,(Three Circuit Breakers)	On
55		9A1A2	400 cps On-Off (Toggle Switch)	On
56		9PS1	Power Ac On (Circuit Breaker)	On
57		9PS2	Power Ac On (Circuit Breaker)	On
58		9PS3	Power On (Toggle Switch)	On
59		9PS4	Power Ac On (Circuit Breaker)	On

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
	VIDEO			
60		61A1A2	Master Visual Power On (Switch)	On
61		61A1A2	Video System (Switch Light)	On
62		61A1A3	Video System CB16 (Three Circuit Breakers)	On
63		8A2A6	On-Off (Toggle Switch)	On
64		8A1A4	On-Off (Toggle Switch)	On
65		8A1A5	Power On (Toggle Switch)	On
66		8A1A6	Power On (Toggle Switch)	On
67		8A2A1	On-Off (Toggle Switch)	On
68		8A2A2	On-Off (Toggle Switch)	On
69		8A2A3	Power On (Toggle Switch)	On
70		8A2A4	AC Line On (Toggle Switch)	On
71		8A2A5	AC Line On (Toggle Switch)	On
72		8A1A3	120VAC Supply CB1 (Circuit Breaker)	On

CAUTION

Insure all DC power supplies are on and regulating. If any supply draws excessive current secure 120VAC Supply CB1 circuit breaker switch and investigate trouble.

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
73		7A1A1	BEAM (Potentiometer)	CCW
74		7A1A3	BEAM (Potentiometer)	CCW

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
75		7A2A1	BEAM (Potentiometer)	CCW
76		7A2A4	BEAM (Potentimeter)	CCW
77		7A1A1	Power On-Off (Toggle Switch)	On
78		7A1A2	On (Toggle Switch)	On
79		7A1A3	Power On-Off (Toggle Switch)	On
80		7A1A6	(Toggle Switch)	On
81		7A2A1	Power On-Off (Toggle Switch)	On
82		7A2A3	Power On (Toggle Switch)	On
83		7A2A4	Power On-Off (Toggle Switch)	On
84		7A2A6	Toggle Switch	On
85		7A2A2	Display Power On Window 2 (Switch)	On
86		7A2A2	Display Power On Window 4 (Switch)	On
	VISUAL DBO			
87		61A1A2	Master Visual Power On (Switch)	On
88		61A1A3	DBO PWR CB17 (Circuit Breaker)	On
89		8A1A3	120VAC Supply CB1 (Circuit Breaker)	On

Table 2-1. Visual System Power Turn On (Cont)

Step	System	Cabinet/ Panel No.	Switch Nomenclature/ Description	Position
	SUN LAMP			
90		61A1A2	Master Visual Power On (Switch)	On
91		61A1A3	Sun Lamp CB18 (Circuit Breaker)	On
92		7A2A2	Rendezvous Illumination Control Sun Manual (Switch)	On
	EARTH LAMP			
93		61A1A2	Master Visual Power On (Switch)	On
94		61A1A3	Earth Lamp CB19 (Circuit Breaker)	On
95		7A2A2	Rendezvous Illumination Control Moon Manual (Switch)	On

2-5. PANEL COMPONENT FUNCTION.

2-6. Tables 2-2 through 2-62 and illustrations 2-1 through 2-60 are included to aid maintenance personnel in locating a panel and/or control and to understand the control or display's function.

2-7. TELESCOPE AND SEXTANT DISPLAY EQUIPMENT CONTROL FUNCTIONS.

2-8. The following tables list all controls, with their functions, used on the telescope/sextant electronics cabinet. Layout illustrations are presented for each cabinet with a table referencing each cabinet panel. Individual panel illustrations and tables, calling out each control and function, are provided.

Table 2-2. Unit 9 Equipment Cabinet/Location of Panels (See figure 2-1)

		For Detail See		
Unit No.	Name	Table No.	Figure No.	Same as
9A1	Test Panel	2-3	2-2	
9PS1	Power Supply	2-4	2-3	
9PS2	Power Supply	2-5	2-4	
9PS3	Power Supply	2-47	2-46	6A1A6
9PS4	Power Supply	2-5	2-4	9PS2
9A2	Power Control Panel	2-6	2-5	

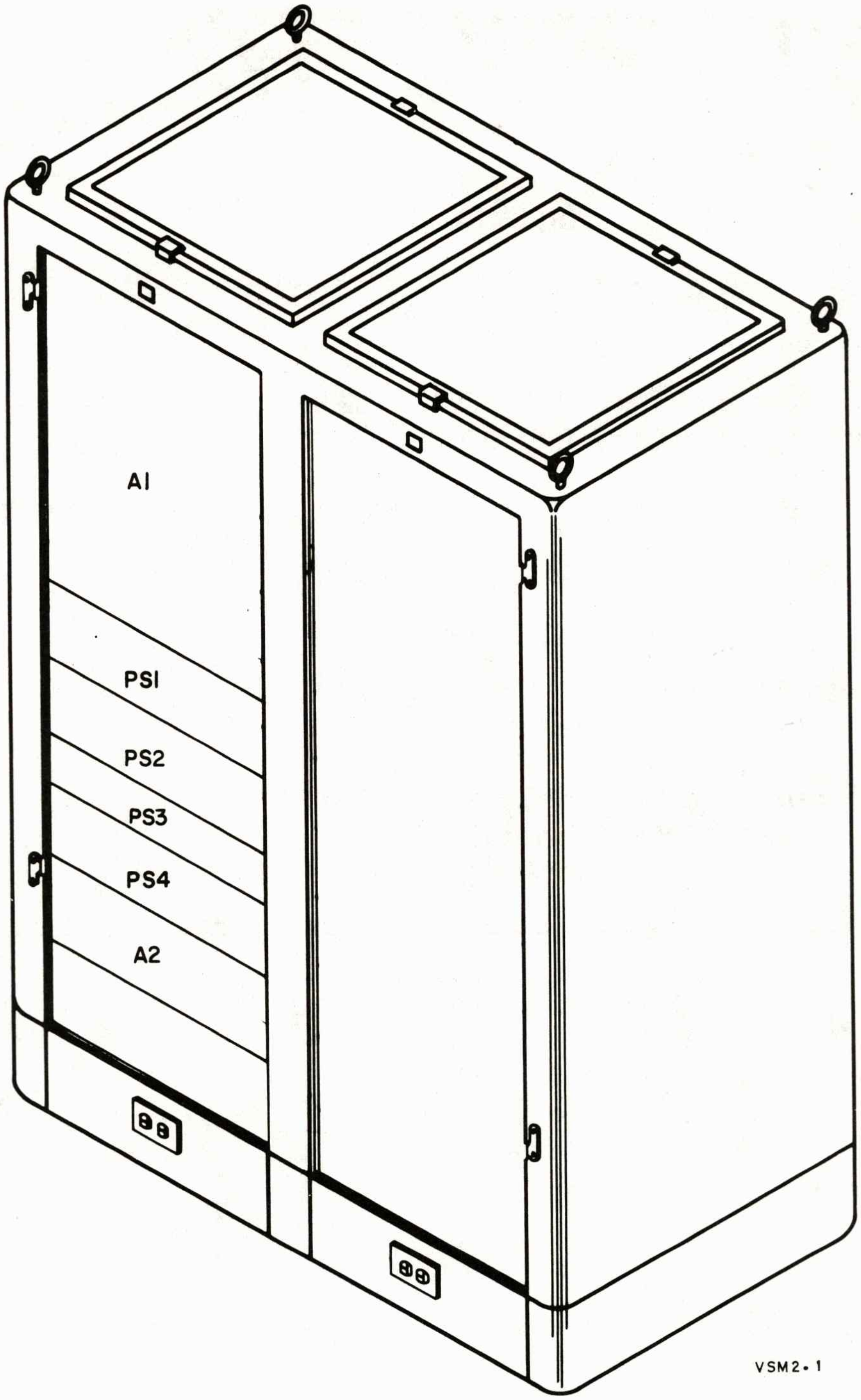


Figure 2-1. Unit 9 Sextant/Telescope Electronics Cabinet Allocation

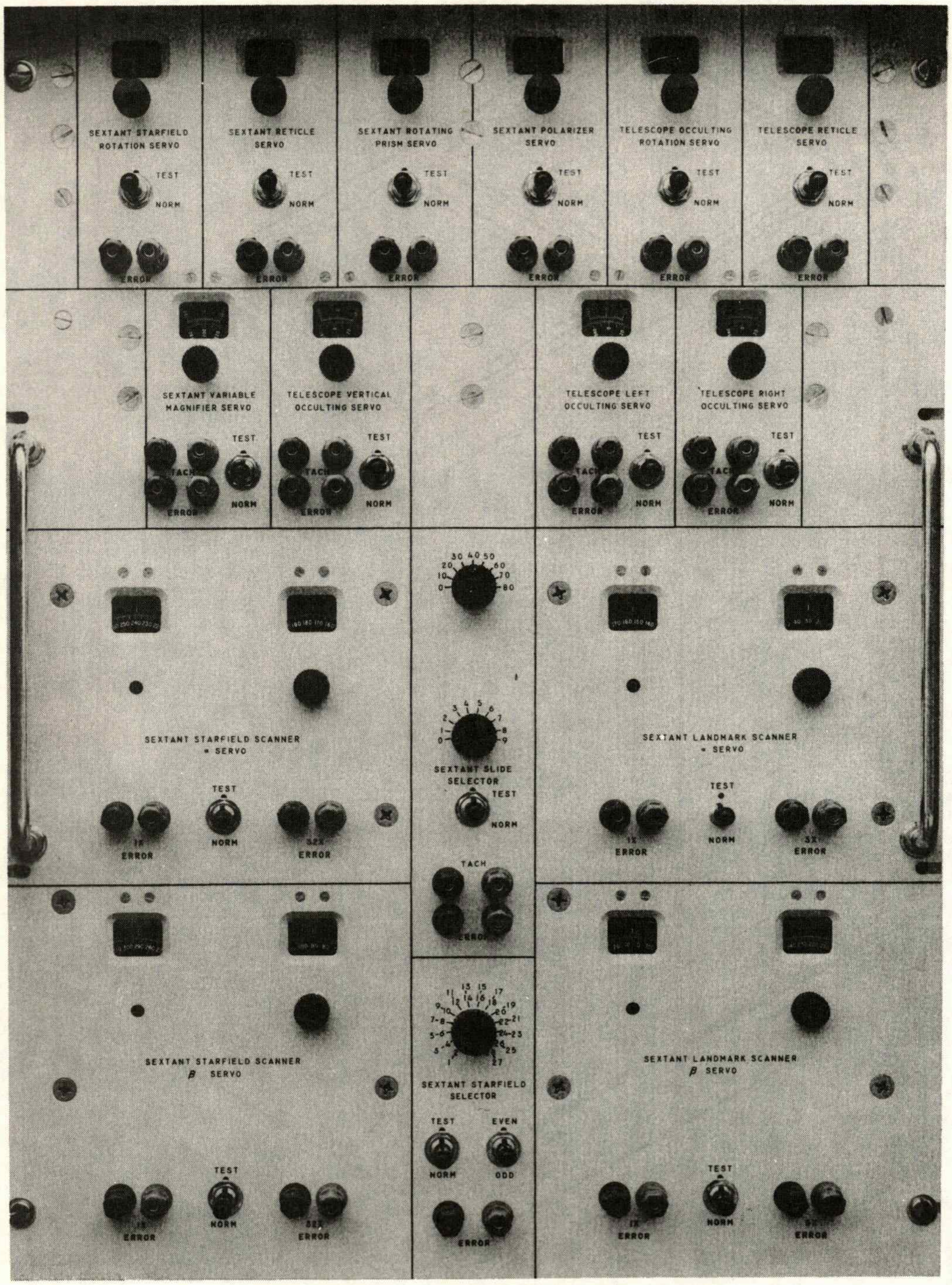


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Figure 2-2. Unit 9A1 Test Panel

Table 2-3. Unit 9A1 Test Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
SEXTANT STARFIELD ROTATION SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP1 and TP2	Test Jacks	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
SEXTANT RETICLE SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP3 and TP4	Test Jacks	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
SEXTANT ROTATING PRISM SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP5 and TP6	Test Jacks	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
SEXTANT POLARIZER SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP7 and TP8	Test Point	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
TELESCOPE OCCULTING ROTATION SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Not Used.

Table 2-3. Unit 9A1 Test Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TEST-NORM	Switch	9A1	2-2	Not Used.
ERROR TP9 and TP10	Test Point	9A1	2-2	Not Used.
TELESCOPE RETICLE SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP11 and TP12	Test Point	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
SEXTANT VARIABLE MAGNIFIER SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP13 and TP14	Test Point	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
TACH TP15 and TP16	Test Point	9A1	2-2	Used for monitoring tach voltage behavior in this servo loop.
TELESCOPE VERTICAL OCCULTING SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP17 and TP18	Test Jack	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
TACH TP19 and TP20	Test Jack	9A1	2-2	Used for monitoring tach voltage behavior in this servo loop.
TELESCOPE LEFT OCCULTING SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.

Table 2-3. Unit 9A1 Test Panel/Control Functions (Cont)

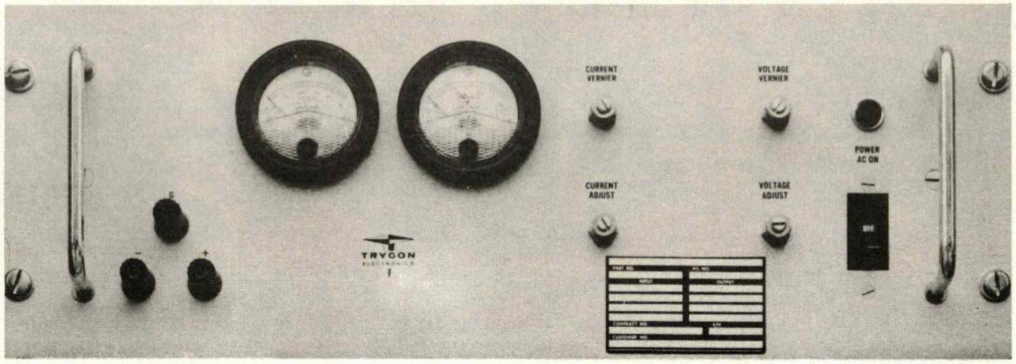
Control or Display	Description	Panel No.	Figure No.	Function
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP17 and TP18	Test Jack	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
TACH TP19 and TP20	Test Jack	9A1	2-2	Used for monitoring tach voltage behavior in this servo loop.
TELESCOPE LEFT OCCULTING SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP21 and TP22	Test Jack	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
TACH TP23 and TP24	Test Jack	9A1	2-2	Used for monitoring tach voltage behavior in this servo loop.
TELESCOPE RIGHT OCCULTING SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
ERROR TP25 and TP26	Test Jack	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
TACH TP27 and TP28	Test Jack	9A1	2-2	Used for monitoring tach voltage behavior in this servo loop.
SEXTANT STARFIELD SCANNER α SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce two speed error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
1X ERROR TP29 and TP30	Test Jack	9A1	2-2	Used for monitoring 1X error voltage in this servo loop.

Table 2-3. Unit 9A1 Test Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
32X ERROR TP31 and TP32	Test Jack	9A1	2-2	Used for monitoring 32X error voltage in this servo loop.
SEXTANT SLIDE SELECTOR				
- Rotary	Switch	9A1	2-2	Provides manual selection of digital input signals for DRC associated with this servo.
- Rotary	Switch	9A1	2-2	Provides manual selection of digital input signals for DRC associated with this servo.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
TACH TP33 and TP34	Test Jack	9A1	2-2	Used for monitoring tach voltage behavior in this servo loop.
ERROR TP35 and TP36	Test Jack	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
SEXTANT LANDMARK SCANNER α SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce two speed error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
1X ERROR TP37 and TP38	Test Jack	9A1	2-2	Used for monitoring 1X error voltage in this servo loop.
32X ERROR TP39 and TP40	Test Jack	9A1	2-2	Used for monitoring 32X error voltage in this servo loop.
SEXTANT STARFIELD SCANNER β SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually intorduce two speed error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
1X ERROR TP41 and TP42	Test Jack	9A1	2-2	Used for monitoring 1X error voltage in this servo loop.
32X ERROR TP43 and TP44	Test Jack	9A1	2-2	Used for monitoring 32X error voltage in this servo loop.

Table 2-3. Unit 9A1 Test Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
SEXTANT STARFIELD SELECTOR				
- Rotary	Switch	9A1	2-2	Selects desired BCD input for this servo system.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test switch.
EVEN-ODD	Switch	9A1	2-2	Controls manual input from either the even or the odd side of the rotary switch.
ERROR TP45 and TP46	Test Jack	9A1	2-2	Used for monitoring error voltage behavior in this servo loop.
SEXTANT LANDMARK SCANNER β SERVO				
Test Director Control Knob	Resolver	9A1	2-2	Used to manually introduce two speed error signal into this servo loop.
TEST-NORM	Switch	9A1	2-2	Switches servo control from AMS computer to manually controlled test director.
1X ERROR TP47 and TP48	Test Jack	9A1	2-2	Used for monitoring 1X error voltage in this servo loop.
32X ERROR TP49 and TP50	Test Jack	9A1	2-2	Used for monitoring 32X error voltage in this servo loop.



VSM2-3

Figure 2-3. Unit 9PS1 Power Supply

Table 2-4. Unit 9PS1 Power Supply (437682)/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
G	Test Jack	9PS1	2-3	Test jack at ground potential used as ground reference when monitoring positive or negative voltages at test jacks + and -.
-	Test Jack	9PS1	2-3	Used to monitor negative voltage output.
+	Test Jack	9PS1	2-3	Used to monitor positive voltage output.
DC VOLTMETER	Voltmeter	9PS1	2-3	Indicates dc voltage level at power supply output. Scale 0 to 50 volts.
Ammeter	Ammeter	9PS1	2-3	Indicates ampere level at power supply output. Scale 0 to 30 amps.
CURRENT VERNIER	Screwdriver, Locking Potentiometer	9PS1	2-3	Fine control of output current.
CURRENT ADJUST	Screwdriver, Locking Potentiometer	9PS1	2-3	Coarse control of output current.
VOLTAGE VERNIER	Screwdriver, Locking Potentiometer	9PS1	2-3	Fine control of output voltage.
VOLTAGE ADJUST	Screwdriver, Locking Potentiometer	9PS1	2-3	Coarse control of output voltage.
Lamp	Lamp	9PS1	2-3	Indicates when "ON-OFF" switch is in the "ON" position.
ON-OFF	Toggle Switch	9PS1	2-3	Controls ac power to the power supply.

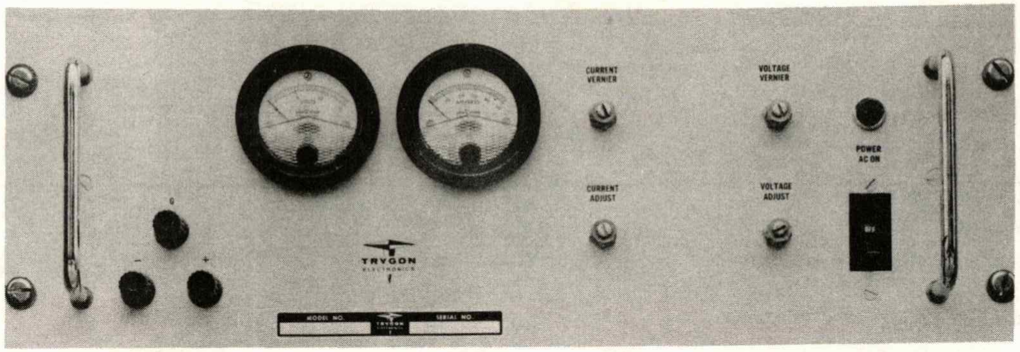
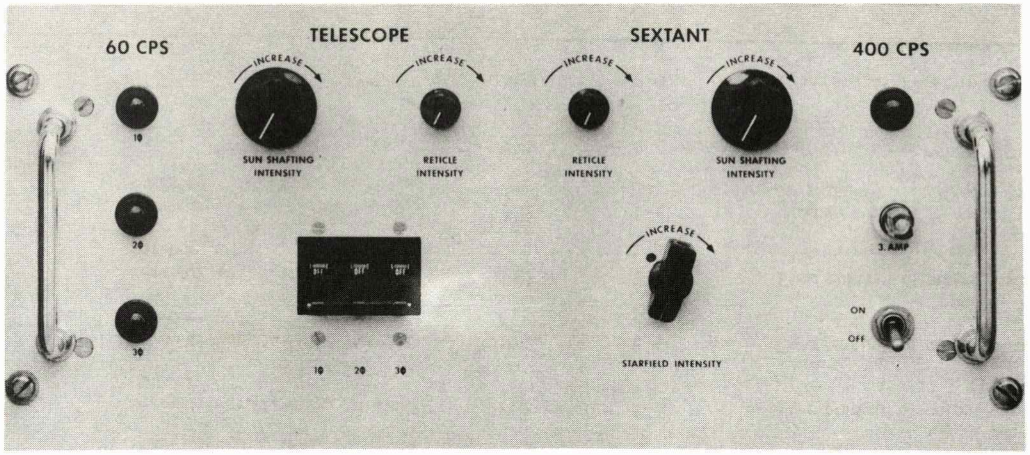


Figure 2-4. Unit 9PS2 Power Supply

Table 2-5. Unit 9PS2 Power Supply (437683)/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
G	Test Jack	9PS2	2-4	Test jack at ground potential used as ground reference when monitoring positive or negative voltages at test jacks + and -.
-	Test Jack	9PS2	2-4	Used to monitor negative voltage output.
+	Test Jack	9PS2	2-4	Used to monitor positive voltage output.
DC VOLTMETER	Meter	9PS2	2-4	Indicates dc voltage level at power supply output. Scale 0 to 15 volts.
Ammeter	Meter	9PS2	2-4	Indicates ampere level at power supply output. Scale 0 to 50 amps.
CURRENT VERNIER	Screwdriver, Locking Potentiometer	9PS2	2-4	Fine control of output current.
CURRENT ADJUST	Screwdriver, Locking Potentiometer	9PS2	2-4	Coarse control of output current.
VOLTAGE VERNIER	Screwdriver, Locking Potentiometer	9PS2	2-4	Fine control of output voltage.
VOLTAGE ADJUST	Screwdriver, Locking Potentiometer	9PS2	2-4	Coarse control of output voltage.
Lamp	Lamp	9PS2	2-4	Indicates when "ON-OFF" switch is in the "ON" position.
ON-OFF	Toggle Switch	9PS2	2-4	Controls ac power to the power supply.



VSM2-5

Figure 2-5. Unit 9A2 Power Control Panel

Table 2-6. Unit 9A2 Power Control Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
10 20 30	Lamp Lamp Lamp	9A2	2-5	Indicates when 3 phase 60 cycle power is applied to the unit.
10 20 30	Switch	9A2	2-5	Circuit breaker type switch used to apply 3 phase 60 cycle power to the unit.
TELESCOPE				
SUN SHAFTING INTENSITY	Control Knob	9A2	2-5	Varies illumination intensity of telescope sunshafting lamp.
RETICLE INTENSITY	Control Knob	9A2	2-5	Varies illumination intensity of telescope reticle lamp.
SEXTANT				
RETICLE INTENSITY	Control Knob	9A2	2-5	Varies illumination intensity of the sextant reticle lamp.
SUN SHAFTING INTENSITY	Control Knob	9A2	2-5	Varies illumination intensity of the sextant sunshafting lamp.
STARFIELD INTENSITY	Control Knob	9A2	2-5	Varies illumination intensity of starfield projector lamp.
ON-OFF	Switch	9A2	2-5	Applies 400 CPS power to the unit.
3 AMP	Fuse	9A2	2-5	Protects 400 CPS power circuits.
Lamp	Lamp	9A2	2-5	Indicates when 400 CPS power is applied to the unit.

2-9. OUT OF THE WINDOW DISPLAY EQUIPMENT CONTROL FUNCTIONS.

2-10. The following tables list all controls, with their functions, used on the out the window display cabinets. Layout illustrations are presented for each cabinet with a table referencing each cabinet panel. Individual panel photographs and tables, calling out each control and function, are provided.

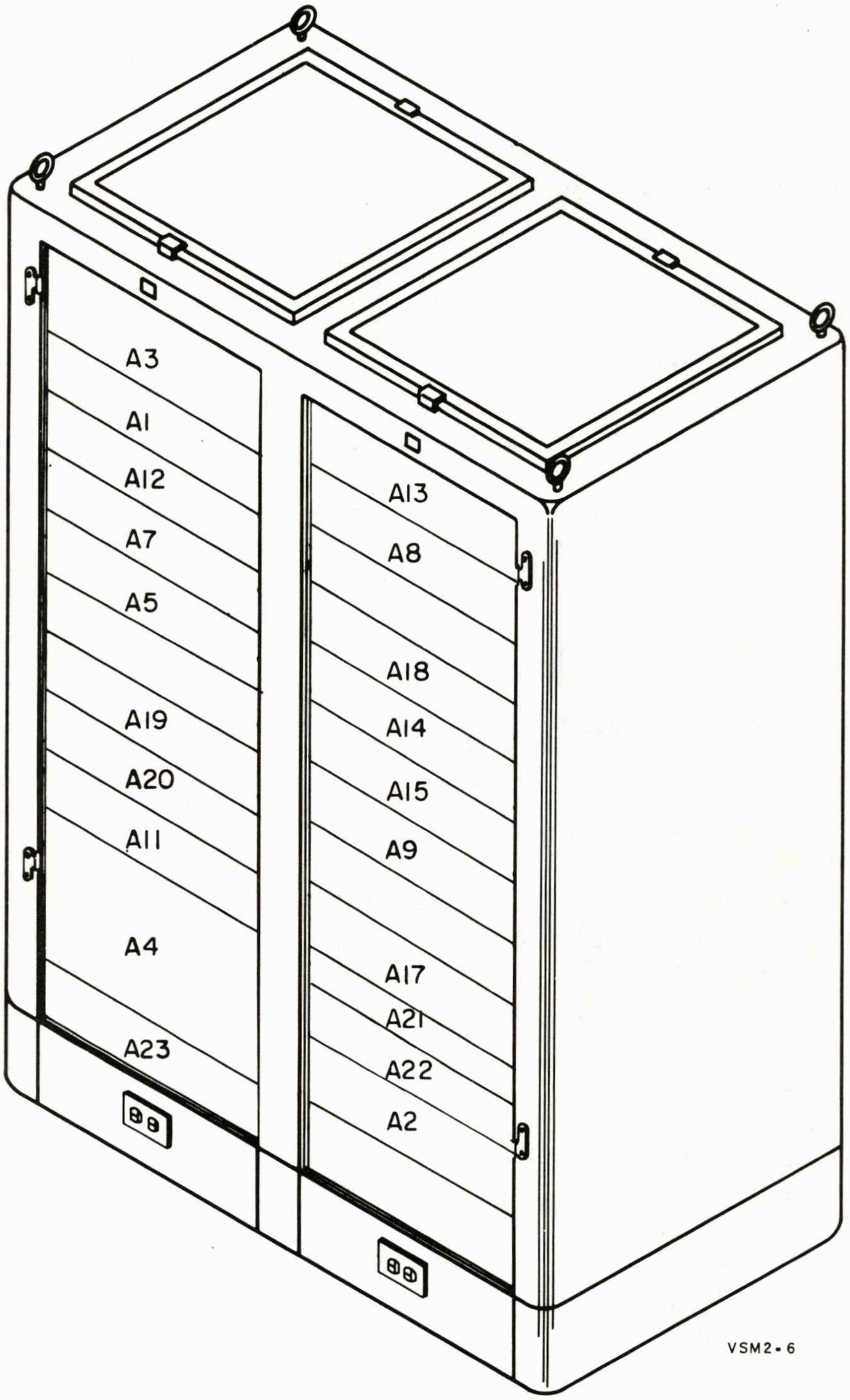


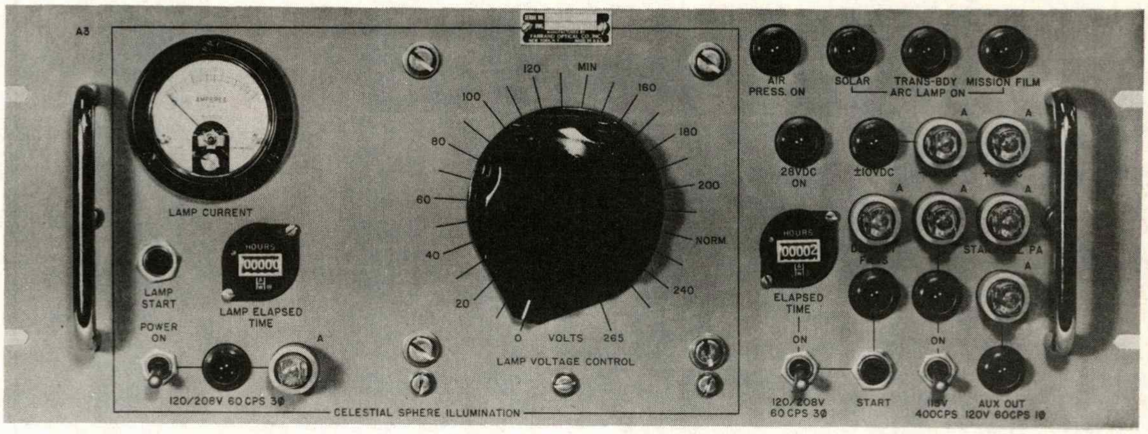
Figure 2-6. Units 70 and 71

Table 2-7. Unit 70 and Unit 71 Equipment Cabinets/Location of Panels (See figure 2-6)

Unit No.	Name	For Detail See Table No.	Figure No.	Same as
70A3	Control Panel	2-8	2-7	
70A1	Celestial Sphere Electronics	2-9	2-8	
70A12	Off Course	2-10	2-9	
70A7	Solar Image	2-11	2-10	
70A5	Earth/Moon Occultation	2-12	2-11	
70A19	Test Panel I	2-13	2-12	
70A20	Test Panel II	2-14	2-13	
70A11	Attitude	2-15	2-14	
70A4	Power Supply	2-45	2-44	6A1A2
70A23	Fuse Panel	2-16	2-15	
70A13	Special Effects Terminator Inclination	2-17	2-16	
70A8	Orbital View	2-18	2-17	
70A18	Trans Earth/Lunar View, Transboundary View	2-19	2-18	
70A14	Vertical Range	2-20	2-19	
70A15	Earth/Moon Illumination, Terminator	2-21	2-20	
70A9	Earth/Moon View Selection, Transboundary Illumination	2-22	2-21	
70A17	Transboundary Effects	2-23	2-22	
70A21	Power Supply	2-47	2-46	6A1A6
70A22	Power Supply	2-47	2-46	6A1A6
70A2	SSI Power Amplifier	2-24	2-23	
71A3	Control Panel	2-8	2-7	70A3
70A1	Celestial Sphere Electronics	2-9	2-8	70A1
71A12	Off-Course	2-10	2-9	70A12
70A7	Solar Image	2-11	2-10	70A7
70A5	Earth/Moon Occultation	2-12	2-11	70A5
70A19	Test Panel I	2-13	2-12	70A19
70A20	Test Panel II	2-14	2-13	70A20
70A11	Attitude	2-15	2-14	70A11
70A4	Power Supply	2-45	2-44	70A4
70A23	Fuse Panel	2-16	2-15	70A23
70A13	Special Effects Terminator Inclinator	2-17	2-16	70A13

Table 2-7. Unit 70 and Unit 71 Equipment Cabinets/Location of Panels (See figure 2-6) (Cont)

Unit No.	Name	For Detail See Table No.	For Detail See Figure No.	Same as
70A8	Orbital View	2-18	2-17	70A8
70A18	Trans Earth/Lunar View, Transboundary View	2-19	2-18	70A18
70A14	Vertical Range	2-20	2-19	70A14
70A15	Earth/Moon Illuminator, Terminator	2-21	2-20	70A15
70A9	Earth/Moon View Selection Transboundary Illumination	2-22	2-21	70A9
70A17	Transboundary Effects	2-23	2-22	70A17
70A21	Power Supply	2-47	2-46	70A21
70A22	Power Supply	2-47	2-46	70A22
70A2	SSI Power Amplifier	2-24	2-23	70A2



VSM2-7

Figure 2-7. Unit 70A3 Control Panel

Table 2-8. Unit 70A3 Control Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
CELESTIAL SPHERE ILLUMINATION				
120/208V 60CPS 3Ø POWER-ON	Toggle Switch	70A3	2-7	Picks up control relay that applies 208 volts to celestial sphere lamp through the variable LAMP VOLTAGE CONTROL transformer.
Lamp	Lamp	70A3	2-7	Indicates when the 120/208V 60CPS 3Ø power-on switch is in the "ON" position.
Fuse	Fuse	70A3	2-7	Provides protection for the 120/208 volt power-on circuits.
LAMP START	Pushbutton Switch	70A3	2-7	Excites the celestial sphere arc-lamp igniter and causes the lamp to ignite.
LAMP ELAPSED TIME	Meter	70A3	2-7	Indicates operating hours on celestial sphere lamp.
LAMP CURRENT	Meter	70A3	2-7	Indicates current being drawn by the celestial sphere lamp.
LAMP VOLTAGE CONTROL	Variable Transformer	70A3	2-7	Controls voltage being applied to the celestial sphere lamp from the 208 volt power source. Voltage can be increased or decreased by varying the transformer control knob.
ON 120/208V 60CPS 3Ø	Toggle Switch	70A3	2-7	Picks up control relay that applies 120V/208V 60CPS 3Ø power to the start button.
START	Pushbutton Switch	70A3	2-7	Applies 120/208V 60CPS 3Ø power to the entire cabinet.
Lamp	Lamp	70A3	2-7	Indicates when 120/208V 60CPS 3Ø power has been applied to the cabinet.
ELAPSED TIME	Meter	70A3	2-7	Indicates operating hours for the cabinet.
115V 400CPS/ON	Toggle Switch	70A3	2-7	Applies 115 volt 400 cps power to the entire cabinet.
Lamp	Lamp	70A3	2-7	Indicates when 115 volts 400cps power switch is in the "ON" position.
5A	Fuse	70A3	2-7	Protects the 115 volt 400 cps circuit.
Lamp	Lamp	70A3	2-7	Indicates when the 120V 60 cps 1Ø power is available at the convenience outlet located at the bottom of the cabinet.
15A	Fuse	70A3	2-7	Provides protection for the 115 volt convenience outlet.

Table 2-8. Unit 70A3 Control Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
2A/DISPLAY FANS	Fuse	70A3	2-7	Provides protection for the cooling fans located in the MEP.
10A/STAR ROLL PA	Fuse	70A3	2-7	Provides protection for the celestial sphere roll-axis power amplifier.
28VDC ON	Lamp	70A3	2-7	Indicates when 28 volts dc is applied to the cabinet.
±10VDC	Lamp	70A3	2-7	Indicates when ±10 volts dc is applied to the cabinet.
10A/-10VDC	Fuse	70A3	2-7	Provides protection for the -10 volts dc circuits.
10A/+10VDC	Fuse	70A3	2-7	Provides protection for the +10 volts dc circuits.
AIR PRES ON	Lamp	70A3	2-7	Indicates when power is applied to the film cooling air compressor.
ARC LAMP ON TRANS-BDY	Lamp	70A3	2-7	Indicates when the Transboundary Arc Lamp has been ignited.
ARC LAMP ON MISSION FILM	Lamp	70A3	2-7	Indicates when the Mission Film Arc Lamp has been ignited.
ARC LAMP ON SOLAR	Lamp	70A3	2-7	Indicates when the Solar Arc Lamp has been ignited.

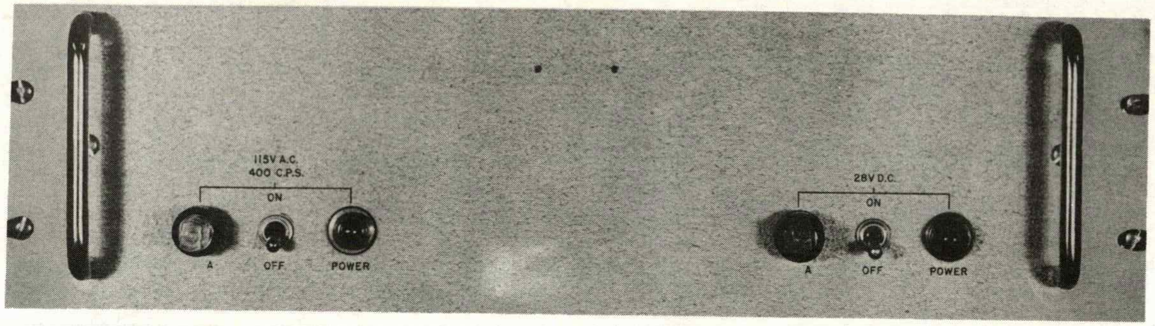


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Figure 2-8. Unit 70A1 Celestial Sphere Electronics

Table 2-9. Unit 70A1 Celestial Sphere Electronics/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
115VAC 400CPS				
.125AMP	Fuse	70A1	2-8	Protects 115V 400 cps power.
ON/OFF	Toggle Switch	70A1	2-8	Applies 115V 400 cps power to the Celestial Sphere.
POWER LAMP	Lamp	70A1	2-8	Indicates when 115VAC 400 cps power switch is in the "ON" position.
28VDC				
10AMP	Fuse	70A1	2-8	Protects 28 volts dc power.
ON/OFF	Toggle Switch	70A1	2-8	Applies 28 volts dc power to the Celestial Sphere.
POWER	Lamp	70A1	2-8	Indicates when the 28 volts dc power switch is in the "ON" position.

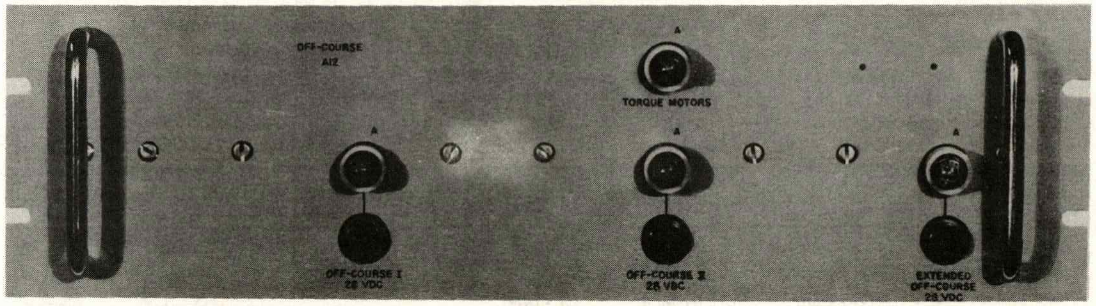
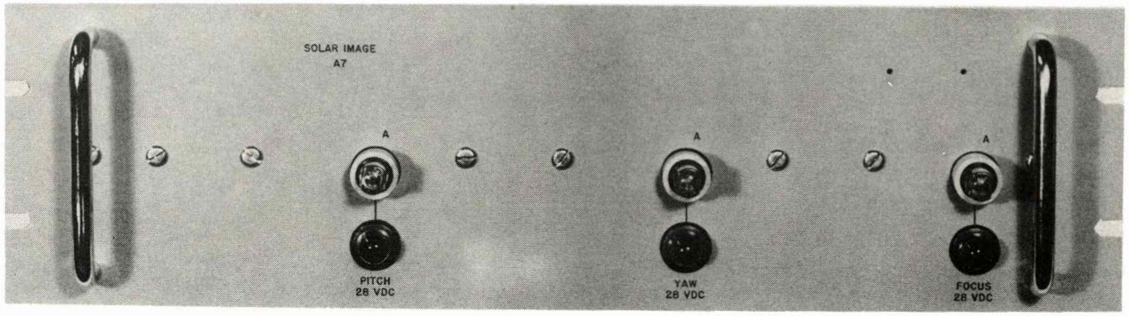


Figure 2-9. Unit 70A12 Off Course

Table 2-10. Unit 70A12 Off-Course/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
OFF COURSE I 28VDC	Fuse	70A12	2-9	Protects the off course I servo amplifier and relays.
OFF COURSE I 28VDC	Lamp	70A12	2-9	Normally illuminated when 28 volt power is applied to the unit. Extinguishes when the off-course I servo drives into its stop.
OFF COURSE II 28VDC	Fuse	70A12	2-9	Protects the off-course II servo amplifier and relays.
OFF COURSE II 28VDC	Lamp	70A12	2-9	Normally illuminated when 28 volt power is applied to the unit. Extinguishes when the off-course II servo drives into its stop.
EXTENDED OFF COURSE 28VDC	Fuse	70A12	2-9	Protects the extended off-course servo amplifier and relays.
EXTENDED OFF COURSE 28VDC	Lamp	70A12	2-9	Normally illuminated when 28 volt power is applied to the unit. Extinguishes when the extended off-course servo drives into its stop.
TORQUE MOTOR	Fuse	70A12	2-9	Protects the torque motors.

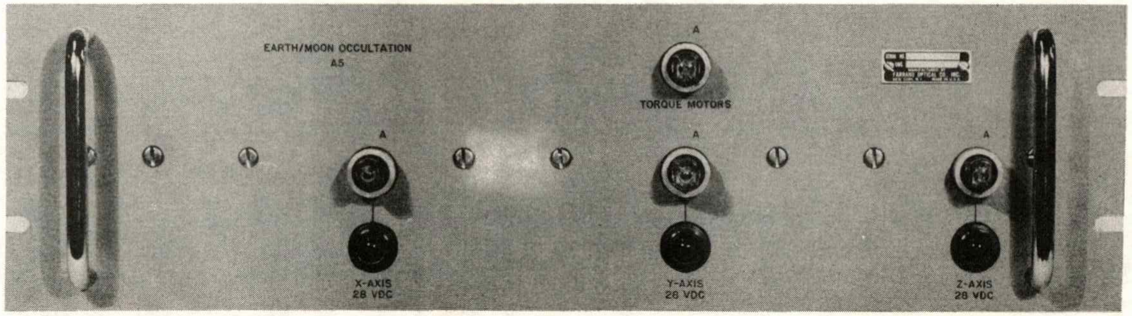


VSM2-10

Figure 2-10. Unit 70A7 Solar Image

Table 2-11. Unit 70A7 Solar Image/Control Functions

Control or Display	Description	Panel No	Figure No.	Function
PITCH 28VDC	1.5A Fuse	70A7	2-10	Protects the pitch servo amplifier and relays.
PITCH 28VDC	Lamp	70A7	2-10	Normally illuminated when 28 volts dc power is applied to the unit. Extinguishes when the pitch servo drives into its stop.
YAW 28VDC	1.5A Fuse	70A7	2-10	Protects the yaw servo amplifier and relays.
YAW 28VDC	Lamp	70A7	2-10	Normally illuminated when 28 volts dc power is applied to the unit. Extinguishes when the yaw servo drives into its stop.
FOCUS 28VDC	1.5A Fuse	70A7	2-10	Protects the focus servo amplifier and relays.
FOCUS 28VDC	Lamp	70A7	2-10	Normally illuminated when 28 volts dc power is applied to the unit. Extinguishes when the focus servo drives into its stop.

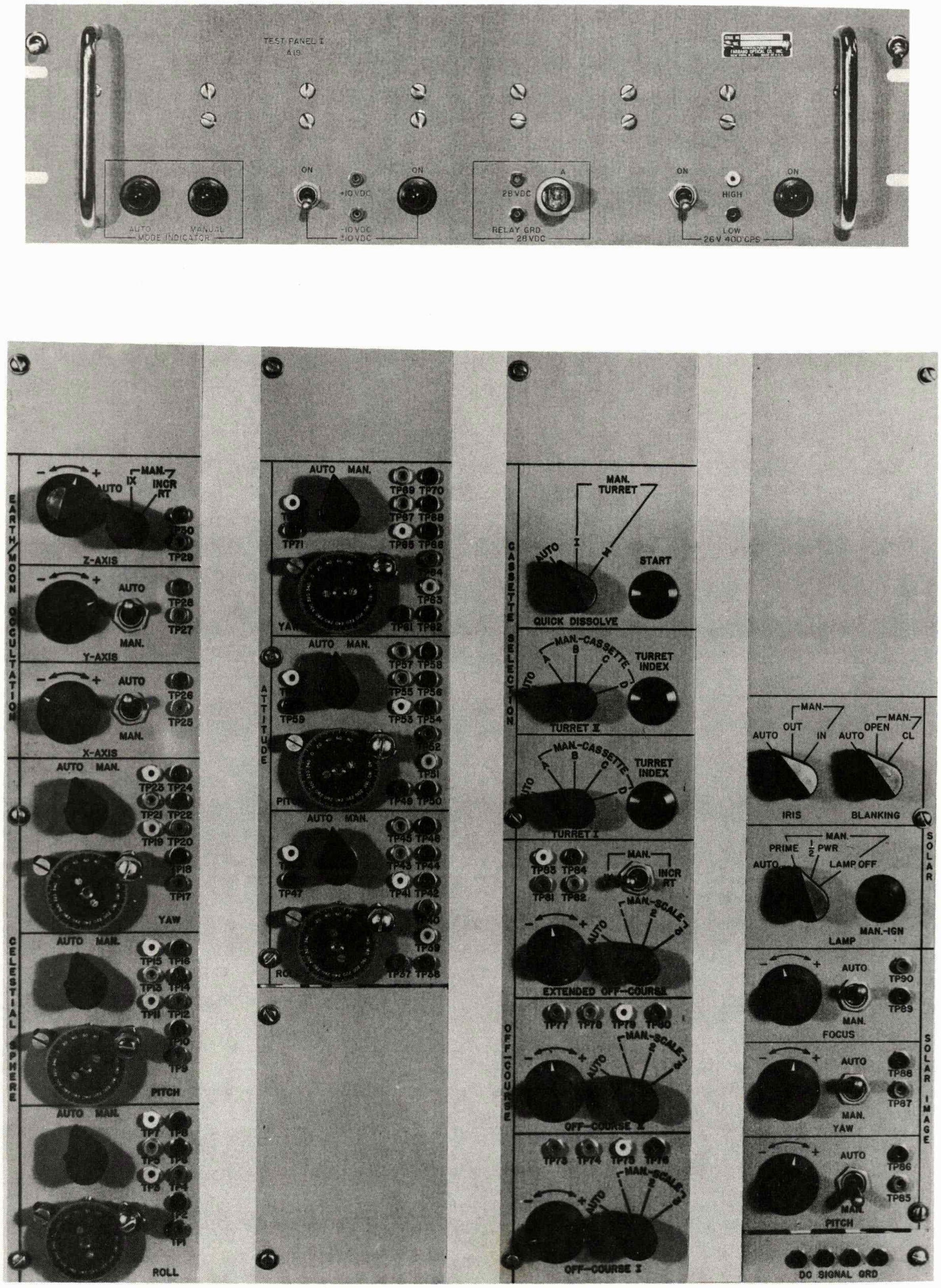


VSM2-11

Figure 2-11. Unit 70A5 Earth/Moon Occultation

Table 2-12. Unit 70A5 Earth/Moon Occultation/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
FUSE	Fuse	70A5	2-11	Protects the X axis 28 volt power.
X-AXIS 28VDC	Lamp	70A5	2-11	Indicates when the X axis servo drives into its stop.
TORQUE MOTORS	Fuse	70A5	2-11	Protects Earth/Moon Occultation torque motors.
FUSE	Fuse	70A5	2-11	Protects the X-axis 28V power.
Y-AXIS 28VDC	Lamp	70A5	2-11	Indicates when the Y-axis servo drives into its stop.
FUSE	Fuse	70A5	2-11	Protects the Z-axis 28 volt power.
Z-AXIS 28VDC	Lamp	70A5	2-11	Indicates when the Z-axis servo drives into its stop.



VSM2-12

Figure 2-12. Unit 70A19 Test Panel I

Table 2-13. Unit 70A19 Test Panel I/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MODE INDICATOR				
AUTO	Lamp	70A19	2-12	Indicates when all Unit 70 Auto/Man test switches are in the "AUTO" position.
MANUAL	Lamp	70A19	2-12	Indicates when any one of the Unit 70 Auto/Man test switches are in the manual position.
±10VDC				
ON	Toggle Switch	70A19	2-12	Applies ±10 volts dc reference voltage to the test potentiometers.
+10VDC	Test Jack	70A19	2-12	Used to monitor +10 volts dc reference voltage.
-10VDC	Test Jack	70A19	2-12	Used to monitor -10 volts dc reference voltage.
ON	Lamp	70A19	2-12	Indicates when ±10 volts dc ON Toggle switch is in the "ON" position.
28VDC				
28VDC	Test Jack	70A19	2-12	Used to monitor 28 volts dc relay voltage.
RELAY GRD	Test Jack	70A19	2-12	Used as ground reference when monitoring 28 volts dc.
26VDC 400 CPS				
ON	Toggle Switch	70A19	2-12	Applies 26 volts dc 400 cps excitation voltage to rotor of the test resolvers.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
HIGH	Test Jack	70A19	2-12	Used to monitor 26 volts 400 cps rotor excitation voltage.
LOW	Test Jack	70A19	2-12	Used to monitor 26 volts 400 cps rotor excitation voltage.
ON	Lamp	70A19	2-12	Indicates when 26 volts 400 cps ON toggle switch is in the "ON" position.
CELESTIAL SPHERE				
ROLL				
Resolver	Resolver	70A19	2-12	Resolver drives the Roll servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	70A19	2-12	Selects input ot the roll servo; either computer input (AUTO) or resolver input (MAN.)
TP1	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP2	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S3 when the AUTO/MAN switch is in the manual position.
TP3	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP4	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP5	Test Jack	70A19	2-12	Used to monitor computer input to roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP6	Test Jack	70A19	2-12	Used to monitor the computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP7	Test Jack	70A19	2-12	Used to monitor the computer input to the roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP8	Test Jack	70A19	2-12	Used to monitor the computer input to the roll servo stator S4 when the ATUO/MAN switch is in the "AUTO" position.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
PITCH				
Resolver	Resolver	70A19	2-12	Resolver drives the pitch servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	70A19	2-12	Selects input to the pitch servo; either computer input (AUTO) or resolver input (MAN).
TP9	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP10	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP11	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP12	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP13	Test Jack	70A19	2-12	Used to monitor computer input to pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP14	Test Jack	70A19	2-12	Used to monitor computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP15	Test Jack	70A19	2-12	Used to monitor the computer input to the pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP16	Test Jack	70A19	2-12	Used to monitor the computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
YAW				
Resolver	Resolver	70A19	2-12	Resolver drives the yaw servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	70A19	2-12	Selects input to the yaw servo; either computer input (AUTO) or resolver input (MAN).
TP17	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP18	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S3 when the AUTO/MAN switch is in the "MAN' position.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP19	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP20	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP21	Test Jack	70A19	2-12	Used to monitor input to yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP22	Test Jack	70A19	2-12	Used to monitor the computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the " "AUTO" position.
TP23	Test Jack	70A19	2-12	Used to monitor the computer input to the yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP24	Test Jack	70A19	2-12	Used to monitor the computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
EARTH/MOON OCCULTATION				
X AXIS				
Potentiometer	Potentiometer	70A19	2-12	Controls the earth/moon occultation X axis servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	70A19	2-12	Selects input to the X axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP25	Test Jack	70A19	2-12	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP25 and d-c signal ground test jacks located at front right corner of the A19 test panel.
TP26	Test Jack	70A19	2-12	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP26 and d-c signal ground test jack located at the front right corner of the A19 test panel.
Y AXIS				
Potentiometer	Potentiometer	70A19	2-12	Controls the earth/moon occultation Y axis servo when the AUTO/MAN switch is in the "MAN" position.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
AUTO/MAN	Toggle Switch	70A19	2-12	Selects input to the Y axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP27	Test Jack	70A19	2-12	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP27 and d-c signal ground test jacks located at front right corner of the A19 test panel.
TP28	Test Jack	70A19	2-12	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP28 and d-c signal ground test jack located at the front right corner of the A19 test panel.
Z AXIS				
Potentiometer	Potentiometer	70A19	2-12	Controls windup of Earth/Moon Occultation tape when AUTO/MAN 1X/INCR RT switch is in either the manual "1X" or manual "INCR RT" position.
AUTO MAN 1X INCR RT	Three Position Selector Switch	70A19	2-12	Selects input to the servo controlling the earth/moon occultation tape; selects computer control, 1X manual (one turn of pot to one revolution of servo) control or INCR RT (one turn of pot turns servo greater than one turn) control.
TP29	Test Jack	70A19	2-12	Used to measure the computer input to the earth/moon occultation servo when the AUTO/MAN switch is in the "AUTO" position.
TP30	Test Jack	70A19	2-12	Used to measure the manual input to the earth/moon occultation servo when the AUTO/MAN switch is in either of the manual position.
ATTITUDE				
ROLL				
Resolver	Resolver	70A19	2-12	Resolver drives the Roll servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	70A19	2-12	Selects input to the roll servo; either two speed computer input (AUTO) or resolver input (MAN).
TP37	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP38	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S3 when the AUTO/MAN switch is in the "MAN" position.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP39	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP40	Test Jack	70A19	2-12	Used to monitor resolver input to roll servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP41	Test Jack	70A19	2-12	Used to monitor the 16X computer input to roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP42	Test Jack	70A19	2-12	Used to monitor the 16X computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP43	Test Jack	70A19	2-12	Used to monitor the 16X computer input to the roll servo S1 when the ATUO/MAN switch is in the "AUTO" position.
TP44	Test Jack	70A19	2-12	Used to monitor the 16X computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP45	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position
TP46	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP47	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP48	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
PITCH				
Resolver	Resolver	70A19	2-12	Resolver drives the pitch servo when the ATUO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	70A19	2-12	Selects input ot the pitch servo; either two speed computer input (AUTO) or resolver input (MAN).

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP49	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP50	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP51	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP52	Test Jack	70A19	2-12	Used to monitor resolver input to pitch servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP53	Test Jack	70A19	2-12	Used to monitor the 8X computer input to pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP54	Test Jack	70A19	2-12	Used to monitor the 8X computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP55	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the pitch servo S1 when the AUTO/MAN switch is in the "AUTO" position.
TP56	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP57	Test Jack	70A19	2-12	Used to monitor the 8X computer input to the pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP58	Test Jack	70A19	2-12	Used to monitor the 8X computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the automatic position.
TP59	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the automatic position.
TP60	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the pitch servo stator S2 when the AUTO/MAN switch is in the automatic position.
YAW				
Resolver	Resolver	70A19	2-12	Resolver drives the yaw servo when the AUTO/MAN selector switch is in the "MAN" position.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
AUTO/MAN	Selector Switch	70A19	2-12	Selects inputs to the yaw servo; either two speed computer input (AUTO) or resolver input (MAN).
TP61	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP62	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP63	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP64	Test Jack	70A19	2-12	Used to monitor resolver input to yaw servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP65	Test Jack	70A19	2-12	Used to monitor the 8X computer input to yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP66	Test Jack	70A19	2-12	Used to monitor the 8X computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP67	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP68	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP69	Test Jack	70A19	2-12	Used to monitor the 8X computer input to the yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP70	Test Jack	70A19	2-12	Used to monitor the 8X computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP71	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP72	Test Jack	70A19	2-12	Used to monitor the 1X computer input to the yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
OFF COURSE				
OFF COURSE I				
Potentiometer	Potentiometer	70A19	2-12	Controls the off course I potentiometer when the AUTO/MAN switch is in any one of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	70A19	2-12	Select input to the off course servo I; Auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.
TP73	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 1. Measured between TP73 and d-c signal ground test jacks, located on front right of A19 test panel.
TP74	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 2. Measured between TP73 and d-c signal ground test jacks, located on front right of A19 test panel.
TP75	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 3. Measured between TP74 and d-c signal ground, located on front right of A19 test panel.
TP76	Test Jack	70A19	2-12	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP76 and d-c signal ground located on front right of A19 test panel.
OFF COURSE II				
Potentiometer	Potentiometer	70A19	2-12	Controls the off course II potentiometer when the AUTO/MAN switch is in any one of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	70A19	2-12	Select input to the off course servo II; Auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP77	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 1. Measured between TP77 and d-c signal ground test jacks, located on front right of A19 test panel.
TP78	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 2. Measured between TP78 and d-c signal ground test jacks, located on front right of A19 test panel.
TP79	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 3. Measured between TP79 and d-c signal ground, located on front right of A19 test panel.
TP80	Test Jack	70A19	2-12	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP80 and d-c signal ground located on front right of A19 test panel.
EXTENDED OFF-COURSE				
Potentiometer	Potentiometer	70A19	2-12	Controls the extended off course potentiometer when the AUTO/MAN switch is in any one of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	70A19	2-12	Select input to the extended of course servo; auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.
MAN-1X/INCR RT	Toggle Switch	70A19	2-12	Allows the manual control potentiometer to drive the extended off course servo at a 1 to 1 rate or, at a greater than 1 to 1 rate.
TP81	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 1. Measured between TP81 and d-c signal ground test jacks, located on front right of A19 test panel.
TP82	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 2. Measured between TP82 and d-c signal ground test jacks, located on front right of A19 test panel.
TP83	Test Jack	70A19	2-12	Used to monitor automatic input signals from computer in mode 3. Measured between TP83 and d-c signal ground, located on front right of A19 test panel.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP84	Test Jack	70A19	2-12	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP84 and d-c signal ground located on front right of A19 test panel.
CASSETTE SECTION				
TURRET I				
ATUO/MAN CASSETTE (ABCD)	Four Position Selector Switch	70A19	2-12	Selects computer control or manual control. In manual control, positions A, B, C, and D are the various positions for setting the turret. The turret will not respond in any manual position until the turret index button is pressed.
TURRET INDEX	Push Button	70A19	2-12	Prevents turret from turning when AUTO/MAN switch is shifted from position to position. Turret will not move in manual control until this button is pressed.
TURRET II				
AUTO/MAN CASSETTE (ABCD)	Four Position Selector Switch	70A19	2-12	Selects computer control or manual control. In manual control, positions A, B, C, and D are the various positions for setting the turret. The turret will not respond in any manual position until the turret index button is pressed.
TURRET INDEX	Push Button	70A19	2-12	Prevents turret from turning when AUTO/MAN switch is shifted from position to position. Turret will not move in manual control until this button is pressed.
QUICK DISSOLVE				
AUTO MAN (I II)	Three Position Selector Switch	70A19	2-12	Selects input control signals for the quick dissolve servo; Computer control (auto), or Manual input I or II.
START	Push Button	70A19	2-12	Prevents quick dissolve servos from turning when the AUTO/MAN switch is turned from position to position. In the manual mode this button must be pushed to cause the servo the drive.
DC SIGNAL GRD				
Four Test Jack	Test Jack	70A19	2-12	Used as a ground reference when measuring d-c test jacks in the A19 test panel. All four ground test jacks are common.

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
SOLAR IMAGE				
PITCH				
Potentiometer	Potentiometer	70A19	2-12	Controls the solar image servo in the pitch axis when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	70A19	2-12	Selects input to the pitch axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP85	Test Jack	70A19	2-12	Used to monitor the computer input when the AUTO/MAN switch is in the automatic position. Reading is taken between TP85 and d-c signal ground located at the front right corner of the A19 test panel.
TP86	Test Jack	70A19	2-12	Used to monitor the manual input potentiometer when the AUTO/MANUAL switch is in the manual position. Reading is taken between TP86 and d-c signal ground located at the right front corner of the A19 test panel.
YAW				
Potentiometer	Potentiometer	70A19	2-12	Controls the solar image servo in the yaw axis when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	70A19	2-12	Selects input to the yaw axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP87	Test Jack	70A19	2-12	Used to monitor the computer input when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP87 and d-c signal ground located at the front right corner of the A19 test panel.
TP88	Test Jack	70A19	2-12	Used to monitor the manual input from potentiometer when the AUTO/MANUAL switch is in the "MAN" position. Reading is taken between TP88 and d-c signal ground located at the right front corner of the A19 test panel.
FOCUS				
Potentiometer	Potentiometer	70A19	2-12	Controls the solar image focus servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	70A19	2-12	Selects input to the focus servo; either computer input (AUTO) or potentiometer input (MAN).

Table 2-13. Unit 70A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP89	Test Jack	70A19	2-12	Used to monitor the computer input when the AUTO/MAN switch is in the automatic position. Reading is taken between TP89 and d-c signal ground located at the front right corner of the A19 test panel.
TP90	Test Jack	70A19	2-12	Used to monitor the "MAN" input potentiometer when the AUTO/MANUAL switch is in the manual position. Reading is taken between TP90 and d-c signal ground located at the right front corner of the A19 test panel.
<u>SOLAR</u>				
<u>LAMP</u>				
AUTO/MAN (PRIME-1/2PWR-LAMP OFF)	Four Position Selector Switch	70A19	2-12	Selects control for the Solar lamp as follows: AUTO; computer control MAN/PRIME; full manual lamp power controlled by test panel A19 MAN/1/2PWR; 1/2 manual lamp power controlled by test panel A19 MAN/LAMP OFF; lamp secured under control of test panel A19
MAN/IGN	Push Button	70A19	2-12	Starts lamp when AUTO/MANUAL selector switch is in MAN/PRIME position.
<u>IRIS/BLANKING</u>				
IRIS-AUTO/MAN (OUT-IN)	Three Position Selector Switch	70A19	2-12	Selects control for solar iris as follows: AUTO; computer control MAN/OUT; iris is moved out from lamp under manual control MAN/IN; iris moved into lamp under manual control
BLANKING-AUTO/MAN (OPEN CL)	Three Position Selector Switch	70A19	2-12	Selects control for blanking shutter as follows: AUTO; computer control MAN/OPEN; blanking shutter open under manual control MAN/CL; blanking shutter closed under manual control

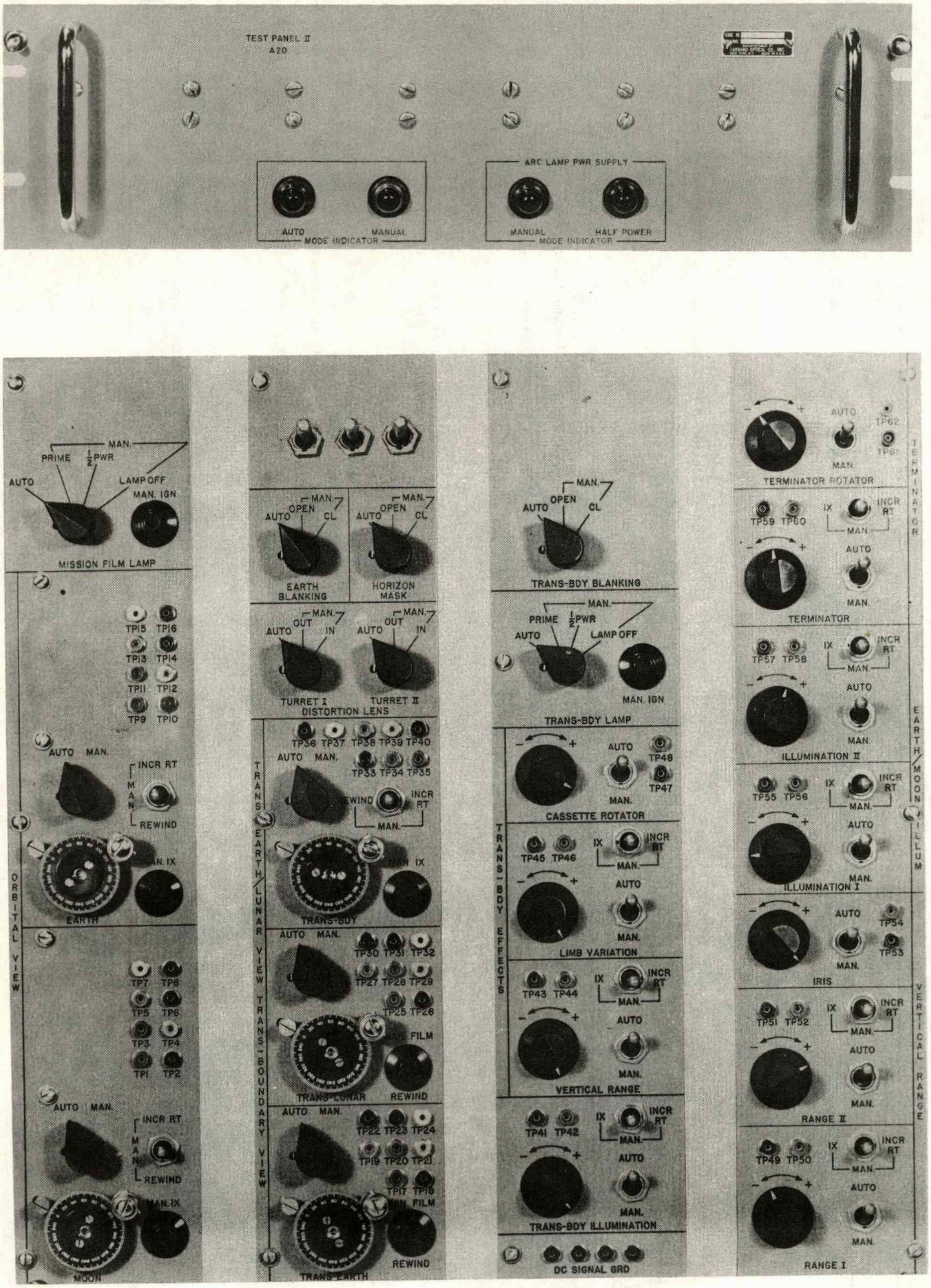


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Figure 2-13. Unit 70A2 Test Panel Assembly II

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MODE INDICATOR				
AUTO	Lamp	70A20	2-13	Indicates when all test switches in the A20 panel are in the automatic position.
MANUAL	Lamp	70A20	2-13	Indicates when any one of the test switches in the A20 panel is in the manual position.
ARC LAMP PWR SUPPLY				
MODE INDICATOR				
MANUAL	Lamp	70A20	2-13	Indicates if the transboundary lamp or mission film lamp AUTO/MAN switch are in any of the manual positions.
HALF POWER	Lamp	70A20	2-13	Indicates if the transboundary lamp AUTO/MAN switch or the mission film lamp AUTO/MAN switch is in the MAN/1/2 PWR position.
ORBITAL VIEW				
MOON				**CAUTION** Before turning the orbital view manual resolver place the moon manual flight direction switch, located at the rear of pan A2 in the position corresponding to the direction of turn of the resolver i.e., counterclockwise is forward and clockwise is reverse.
Resolver	Resolver	70A20	2-13	Resolver controls the orbital view moon servo when the AUTO/MAN selector switch is in the manual position. This resolver when turned counterclockwise will drive the orbital view moon film forward. When the resolver is turned clockwise the film will move backward.
MAN-INCR RT/REWIND	Momentary Contact Toggle Switch	70A20	2-13	This is a momentary release switch that is operated in the following manner. Pushing the switch to the rewind position causes the film to automatically rewind. Pushing the switch to the INCR RT position places the film under control of the manual resolver. The film will move at an increased rate.
MAN 1X	Push Button	70A20	2-13	Connects the manual resolver to the orbital view moon servo motor at a 1X rate.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP1	Test Jack	70A20	2-13	Used to monitor manual input to the orbital view moon servo at stator S1.
TP2	Test Jack	70A20	2-13	Used to monitor manual inputs to the orbital view moon servo at stator S3.
TP3	Test Jack	70A20	2-13	Used to monitor manual inputs to the orbital view moon servo at stator S4.
TP4	Test Jack	70A20	2-13	Used to monitor manual inputs to the orbital view moon servo at stator S2.
TP5	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view moon servo at stator S1.
TP6	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view moon servo at stator S3.
TP7	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view moon servo at stator S2.
TP8	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view moon servo at stator S4.
EARTH				**CAUTION** Before turning the orbital view manual resolver place the earth manual flight direction switch, located at the rear of pan A2 in the position corresponding to the direction of turn of the resolver i.e., counterclockwise is forward and clockwise is reverse.
Resolver	Resolver	70A20	2-13	Resolver controls the orbital view earth servo when the AUTO/MAN selector switch is in the "MAN" position. This resolver when turned counterclockwise will drive the orbital view moon film forward. When the resolver is turned clockwise the film will move backward.
MAN-INCR RT/REWIND	Momentary Contact Toggle Switch	70A20	2-13	This is a momentary release switch that is operate in the following manner. Pushing the switch to rewind position causes the film to automatically rewind. Pushing the switch to the INCR RT position places the film under control of the manual resolver. The film will move to an increased rate.
MAN 1X	Push Button	70A20	2-13	Connects the manual resolver to the orbital view earth servo motor at a 1X rate.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP9	Test Jack	70A20	2-13	Used to monitor the manual inputs to the orbital view earth servo at stator S1.
TP10	Test Jack	70A20	2-13	Used to monitor manual inputs to the orbital view earth servo at stator S3.
TP11	Test Jack	70A20	2-13	Used to monitor manual inputs to the orbital view earth servo at stator S2.
TP12	Test Jack	70A20	2-13	Used to monitor manual inputs to the orbital view earth servo at stator S4.
TP13	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view earth servo at stator S1.
TP14	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view earth servo at stator S3.
TP15	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view earth servo at stator S2.
TP16	Test Jack	70A20	2-13	Used to monitor computer inputs to orbital view earth servo at stator S4.
MISSION FILM LAMP				
AUTO/MAN (PRIME-1/2PWR-LAMP OFF	Four Position Selector Switch	70A20	2-13	Selects control for the Solar lamp as follows: AUTO; computer control MAN/PRIME; full manual lamp power controlled by test panel A19 MAN/1/2PWR; 1/2 manual lamp power controlled by test panel A19 MAN/LAMP OFF; lamp secured under control of test panel A19
MAN/IGN	Push Button	70A20	2-13	Statrs lamp when AUTO/MANUAL selector switch is in MAN/PRIME position.
TRANS EARTH/LUMAR VIEW				
TRANS BOUNDARY VIEW				
TRANS EARTH				
Resolver	Resolver	70A20	2-13	Resolver control for the trans-earth servo when the AUTO/MAN selector switch is in the "MAN" position.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
REWIND	Push Button	70A20	2-13	Causes the trans-earth film to automatically rewind. AUTO/MAN selector switch must be in the manual position.
AUTO/MAN	Selector Switch	70A20	2-13	Selects inputs to trans-earth servo; either resolver control (manual) or computer control (automatic).
TP17	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-earth servo at stator S1.
TP18	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-earth servo at stator S3.
TP19	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-earth servo at stator S1.
TP20	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-earth servo at stator S4.
TP21	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-earth servo at stator S2.
TP22	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-earth servo at stator S3.
TP23	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-earth servo at stator S4.
TP24	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-earth servo at stator S2.
TRANS LUNAR				
Resolver	Resolver	70A20	2-13	Resolver control for the trans-lunar servo when the AUTO/MAN selector switch is in the "MAN" position.
REWIND	Push Button	70A20	2-13	Causes the trans-lunar film to automatically rewind. AUTO/MAN selector switch must be in the manual position.
AUTO/MAN	Selector Switch	70A20	2-13	Selects inputs to trans-lunar servo; either resolver control (manual) or computer control (automatic).
TP25	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-lunar servo at stator S1.
TP26	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-lunar servo at stator S3.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP27	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-lunar servo at stator S1.
TP28	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-lunar servo at stator S4.
TP29	Test Jack	70A20	2-13	Used to monitor the resolver input to the trans-lunar servo at stator S2.
TP30	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-lunar servo at stator S3.
TP31	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-lunar servo at stator S4.
TP32	Test Jack	70A20	2-13	Used to monitor the computer input to the trans-lunar servo at stator S2.
TRANS BDY				CAUTION Before turning the transboundary view manual resolver place the transboundary manual flight direction switch, located at the rear of pan A2 in the position corresponding to the direction of turn of the resolver i.e., counterclockwise is forward and clockwise is reverse.
Resolver	Resolver	70A20	2-13	Resolver controls the transboundary view servo when the AUTO/MAN selector switch is in the "MAN" position. This resolver when turned counterclockwise will drive the transboundary view film forward. When the resolver is turned clockwise the film will move backward.
MAN-INCR RT/REWIND	Momentary Contact Toggle Switch	70A20	2-13	This is a momentary release switch that is operated in the following manner: pushing the switch to the rewind position causes the film to automatically rewind. Pushing the switch to the INCR RT position places the film under control of the manual resolver. The film will move at an increased rate.
MAN 1X	Push Button	70A20	2-13	Connects the manual resolver to the orbital view servo motor at a 1X rate.
TP33	Test Jack	70A20	2-13	Used to monitor computer inputs to the trans-boundary servo at stator S3.
TP34	Test Jack	70A20	2-13	Used to monitor manual inputs to the trans-boundary servo at stator S4.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Dispaly	Description	Panel No.	Figure No.	Function
TP35	Test Jack	70A20	2-13	Used to monitor manual inputs to the trans-boundary servo at stator S1.
TP36	Test Jack	70A20	2-13	Used to monitor computer inputs to the trans-boundary servo at stator S4.
TP37	Test Jack	70A20	2-13	Used to monitor computer inputs to trans-boundary servo at stator S2.
TP38	Test Jack	70A20	2-13	Used to monitor computer inputs to trans-boundary servo at stator S1.
TP39	Test Jack	70A20	2-13	Used to monitor manual inputs to trans-boundary servo at stator S2.
TP40	Test Jack	70A20	2-13	Used to monitor manual inputs to trans-boundary servo at stator S3.
DISTORTION LENS				
Turret I				
AUTO/MAN (OUT-IN)	Three Position Selector Switch	70A20	2-13	Controls input to the turret I distortion lens servo as follows: AUTO; computer control MAN OUT; test signal drives the servo into its stop so that the lens is positioned at the "OUT" stop MAN IN; test signal drives the servo into its stop so that the lens is positioned at the "IN" stop
Turret II				
AUTO/MAN (OUT-IN)	Three Position Selector Switch	70A20	2-13	Controls input to the turret II distortion lens servo as follows: AUTO; computer control MAN OUT; test signal drives the servo into its stop so that the lens is positioned at the "OUT" stop MAN IN; test signal drives the servo into its stop so that the lens is positioned at the "IN" stop
EARTH BLANKING				
AUTO/MAN (OPEN CL)	Three Position Selector Switch	70A20	2-13	Controls input to the earth blanking servo as follows: AUTO; computer control MAN OPEN; applies test signal to fully open the earth blanking control MAN CL; applies test signal to fully close the earth blanking control

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
HORIZON MASK				
AUTO/MAN (OPEN CL)	Three Position Selector Switch	70A20	2-13	Controls input to the horizon mask servo as follows: AUTO; computer control MAN OPEN; applies test signal to fully open the horizon mask control MAN CL; applies test signal to fully close the horizon mask control
MANUAL FLIGHT DIRECTION				
EARTH				
FORWARD/REVERSE	Toggle Switch	70A20	2-13	Removes tension from take up reel in direction of film wind up. See Orbital View pan A1.
MOON				
FORWARD/REVERSE	Toggle Switch	70A20	2-13	Removes tension from take up reel in direction of film wind up. See Orbital View pan A1.
TRANS/BDY				
FORWARD/REVERSE	Toggle Switch	70A20	2-13	Removes tension from take up reel in direction of film wind up. See trans-boundary view pan A2.
DC SIGNAL GRD				
Four Test Jacks	Test Jacks	70A20	2-13	Used as ground reference when measuring d-c reference voltages at panel A20.
TRANS-BDY ILLUMINATION				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the trans-boundary illumination servo when the AUTO/MAN toggle switch is in the manual position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the transboundary illumination servo; either computer control (automatic) or potentiometer control (manual).
MAN (1X-INCR RT)	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the transboundary illumination servo at a 1 times rate or at an increased rate, when the AUTO/MAN switch is in the manual position.
TP41	Test Jack	70A20	2-13	Used to monitor the computer input to the transboundary illumination servo.
TP42	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the trans-boundary illumination servo.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TRANS BOUNDARY EFFECTS				
VERTICAL RANGE				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the vertical range servo when the AUTO/MAN toggle switch is in the manual position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the vertical range servo; either computer control (automatic) or potentiometer control (manual).
MAN (1X-INCR RT)	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the vertical range servo at a 1 times rate or at an increase rate when the AUTO/MAN switch is in the manual position.
TP43	Test Jack	70A20	2-13	Used to monitor the computer input to the vertical range servo.
TP44	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the vertical range servo.
LIMB VARIATION				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the limb variation servo when the AUTO/MAN toggle switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the limb variation servo; either computer control (automatic) or potentiometer control (manual).
MAN (1X-INCR RT)	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the limb variation servo at a 1 times rate or at an increased rate, when the AUTO/MAN switch is in the manual position.
TP45	Test Jack	70A20	2-13	Used to monitor the computer input to the limb variation servo.
TP46	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the limb variation servo.
CASSETTE ROTATOR				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the cassette rotator servo when the AUTO/MAN toggle switch is in the manual position.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the cassette rotator servo; either, computer control (automatic) or potentiometer control (manual).
TP47	Test Jack	70A20	2-13	Used to monitor the computer input to the cassette rotator servo.
TP48	Test Jack	70A20	2-13	Used to monitor the potentiometer input to the cassette rotator servo.
TRANS-BDY BLANKING				
AUTO/MAN (OPEN-CL)	Three Position Selector Switch	70A20	2-13	Selects control for blanking shutter as follows: AUTO; computer control MAN/OPEN; blanking shutter open under manual control MAN/CL; blanking shutter closed under manual control
VERTICAL RANGE				
RANGE I				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the range I servo when the AUTO/MAN toggle switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the range I servo; either computer control (automatic) or potentiometer control (manual).
MAN (1X-INCR RT)	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the range I servo at a 1 times rate or at an increased rate when the AUTO/MAN switch is in the manual position.
TP49	Test Jack	70A20	2-13	Used to monitor the computer input to the range I servo.
TP50	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the range I servo.
RANGE II				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the range II servo when the AUTO/MAN toggle switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the range II servo; either computer control (automatic) or potentiometer control (manual).
MAN (1X-INCR RT	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the range II servo at a 1 times rate or at an increased rate, when the AUTO/MAN switch is in the manual position.
TP51	Test Jack	70A20	2-13	Used to monitor the computer input to the range II servo.

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP52	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the range II servo.
IRIS				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the iris servo when the AUTO/MAN toggle switch is in the manual position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the iris servo; either computer control (automatic) or potentiometer control (manual).
TP53	Test Jack	70A20	2-13	Used to monitor the computer input to the iris servo.
TP54	Test Jack	70A20	2-13	Used to monitor the potentiometer input to the iris servo.
EARTH MOON ILLUMINATION				
ILLUMINATION I				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the illumination I servo when the AUTO/MAN toggle switch is in the manual position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the illumination I servo; either computer control (automatic) or potentiometer control (manual).
MAN (1X-INCR RT)	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the illumination I servo at a 1 times rate or at an increased rate, when the AUTO/MAN switch is in the manual position.
TP55	Test Jack	70A20	2-13	Used to monitor the computer input to the illumination servo.
TP56	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the illumination I servo.
ILLUMINATION II				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the illumination II servo when the AUTO/MAN toggle switch is in the manual position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the illumination II servo; either computer control (automatic) or potentiometer control (manual).

Table 2-14. Unit 70A20 Test Panel Assembly II/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
MAN (1X-INCR RT)	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the illumination II servo at a 1 times rate or at an increased rate, when the AUTO/MAN switch is in the manual position.
TP57	Test Jack	70A20	2-13	Used to monitor the computer input to the illumination II servo.
TP58	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the illumination II servo.
TERMINATOR				
TERMINATOR				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the terminator servo when the AUTO/MAN toggle switch is in the manual position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the terminator servo; either computer control (automatic) or potentiometer control (manual).
MAN (1X-INCR RT)	Toggle Switch	70A20	2-13	Connects the manual potentiometer to the terminator servo at a 1 times rate or at an increased rate, when the AUTO/MAN switch is in the manual position.
TP59	Test Jack	70A20	2-13	Used to monitor the computer input to the terminator servo.
TP60	Test Jack	70A20	2-13	Used to monitor the manual potentiometer input to the terminator servo.
TERMINATOR ROTATOR				
Potentiometer	Potentiometer	70A20	2-13	Potentiometer control for the terminator rotator servo when the AUTO/MAN toggle switch is in the manual position.
AUTO/MAN	Toggle Switch	70A20	2-13	Selects input to the terminator rotator servo; either computer control (automatic) or potentiometer control (manual).
TP61	Test Jack	70A20	2-13	Used to monitor the computer input to the terminator rotator servo.
TP62	Test Jack	70A20	2-13	Used to monitor the potentiometer input to the terminator rotator servo.

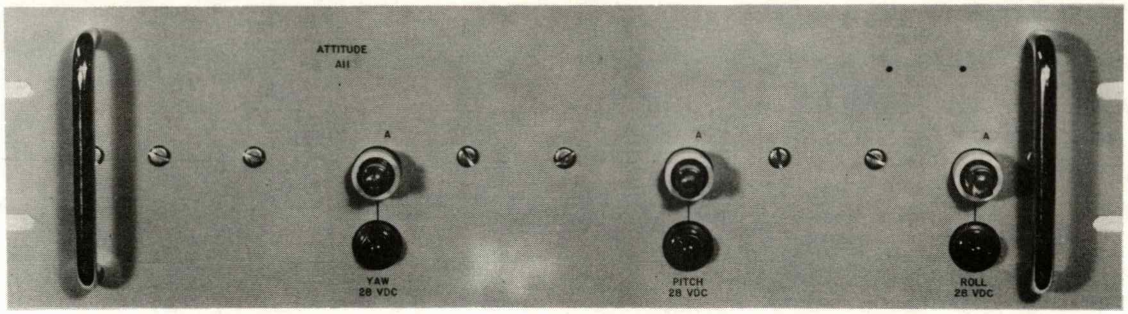

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Figure 2-14. Unit 70A11 Attitude

Table 2-15. Unit 70A11 Attitude/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
YAW 28VDC	1.5A Fuse	70A11	2-14	Protects the yaw servo amplifier and relays.
YAW 28VDC	Lamp	70A11	2-14	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the yaw servo drives into its stop.
PITCH 28VDC	1.5A Fuse	70A11	2-14	Protects the pitch servo amplifier and relays.
PITCH 28VDC	Lamp	70A11	2-14	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the pitch servo drives into its stop.
ROLL 28VDC	1.5A Fuse	70A11	2-14	Protects the roll servo amplifier and relays.
ROLL 28VDC	Lamp	70A11	2-14	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the roll servo drives into its stop.

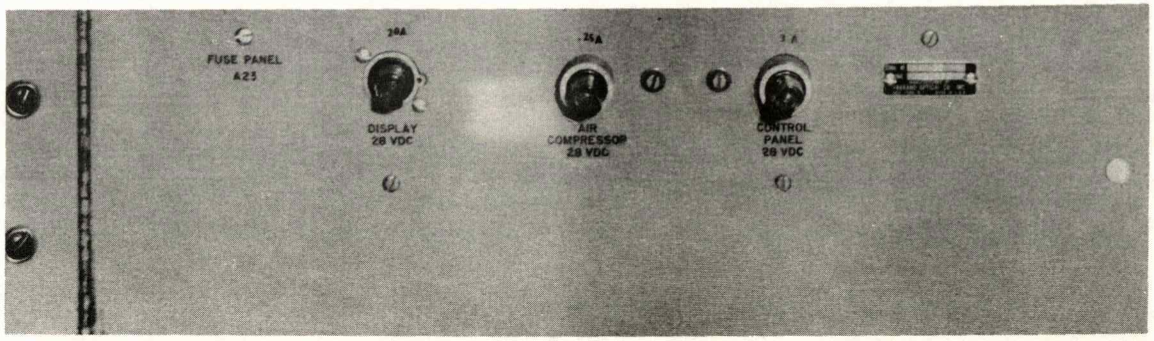

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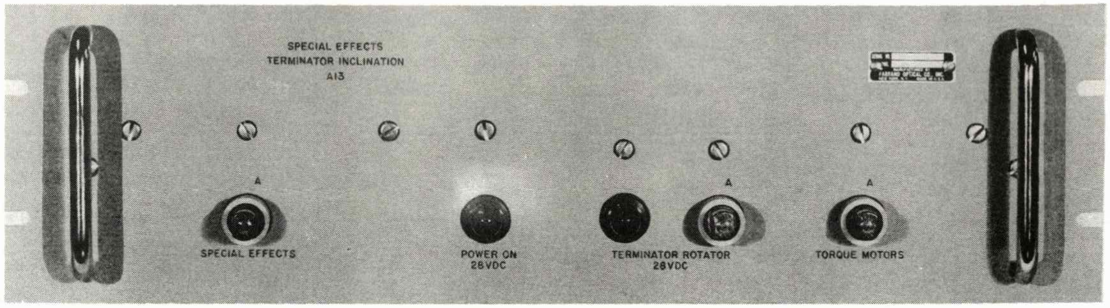
Figure 2-15. Unit 70A23 Fuse Panel

Table 2-16. Unit 70A23 Fuse Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
DISPLAY 28VDC	10A Fuse	70A23	2-15	Protects the 28 volts dc display circuits.
AIR COMPRESSOR 28VDC	25A Fuse	70A23	2-15	Protects the 28 volts dc compressor control circuit.
CONTROL PANEL 28VDC	3A Fuse	70A23	2-15	Protects the 28 volts dc control panel circuits.

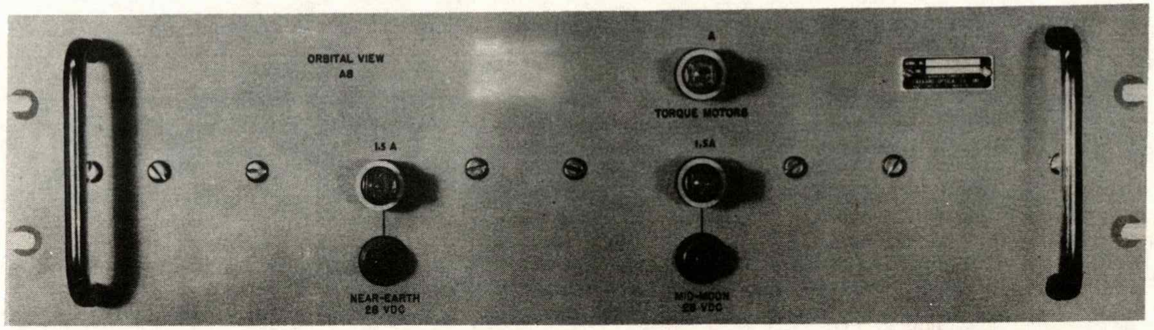


VSM2-16

Figure 2-16. Unit 70A13 Special Effects Terminator Inclination

Table 2-17. Unit 70A13 Special Effects Termination Inclination/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
-A SPECIAL EFFECTS	Fuse	70A13	2-16	Protection for special effects 28 vdc circuits.
POWER ON 28VDC	Lamp	70A13	2-16	Indicates when the volts dc power is applied to the unit.
TERMINATOR ROTATOR 28VDC				
Lamp	Lamp	70A13	2-16	Indicates when the Terminator Rotator servo drives into its stop.
Fuse	Fuse	70A13	2-16	Protection for the Terminator Rotator 28 vdc power.
TORQUE MOTORS	Fuse	70A13	2-16	Protection for the special effects torque motors.

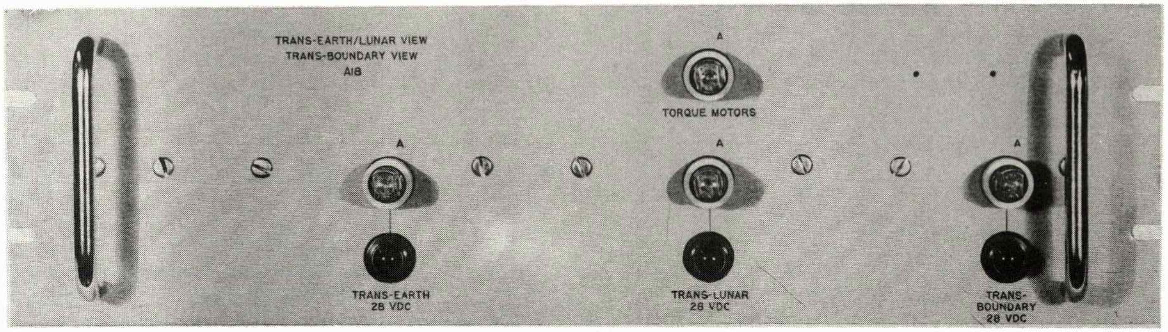


VSM2-17

Figure 2-17. Unit 70A8 Orbital View

Table 2-18. Unit 70A8 Orbital View/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
NEAR EARTH 28VDC	Fuse	70A8	2-17	Protects the near earth servo amplifier and relays.
NEAR EARTH 28VDC	Lamp	70A8	2-17	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the near earth servo drives into its stop.
MID MOON 28VDC	Fuse	70A8	2-17	Protects the near earth servo amplifier and relays.
MID MOON 28VDC	Lamp	70A8	2-17	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the near earth servo drives into its stop.
TORQUE MOTORS	Fuse	70A8	2-17	Protects the torque motors.

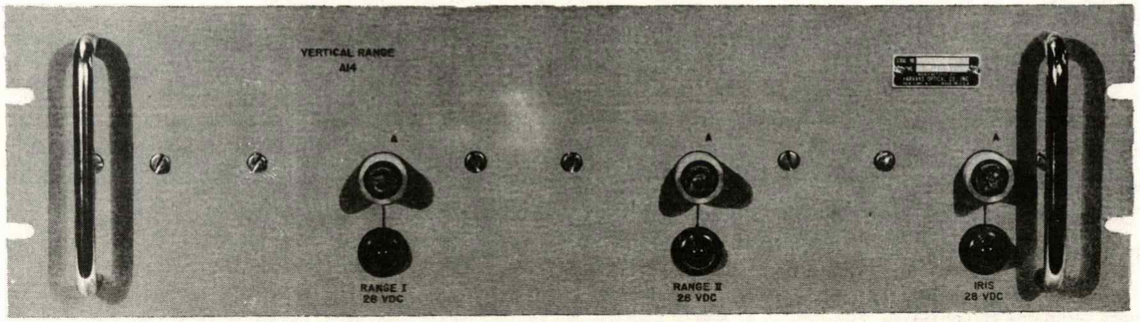


VSM2

Figure 2-18. Unit 70A18 Trans-Earth/Lunar View Transboundary View

Table 2-19. Unit 70A18 Trans-Earth/Lunar View Transboundary View/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
TRANS-EARTH 28VDC	1.5A Fuse	70A18	2-18	Protects the trans-earth servo amplifier and relays.
TRANS-EARTH 28VDC	Lamp	70A18	2-18	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the trans-earth servo drives into its stop.
TRANS-LUNAR 28VDC	1.5A Fuse	70A18	2-18	Protects the trans-lunar servo amplifier and relays.
TRANS-LUNAR 28VDC	Lamp	70A18	2-18	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the transboundary servo drives into its stop.
TORQUE MOTOR	3A Fuse	70A18	2-18	Protects the torque motors.

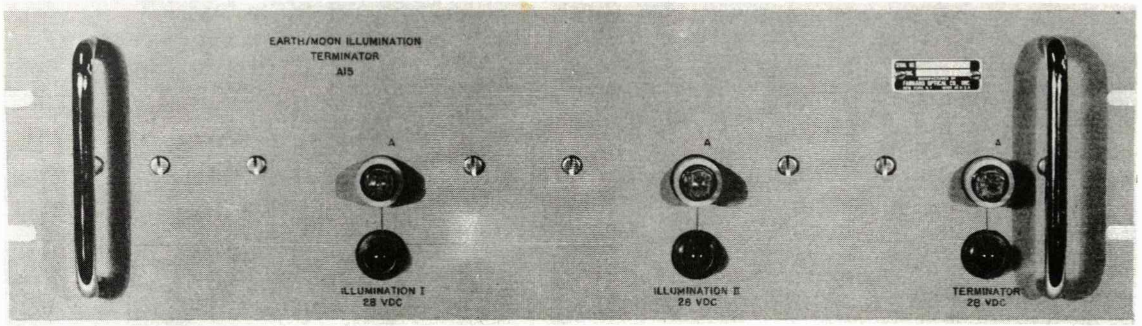


VSM2-19

Figure 2-19. Unit 70A14 Vertical Range

Table 2-20. Unit 70A14 Vertical Range/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
RANGE I 28VDC	1A Fuse	70A14	2-19	Protects the range I servo amplifier and relays.
RANGE I 28VDC	Lamp	70A14	2-19	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the range I servo drives into the stop.
RANGE II 28VDC	1A Fuse	70A14	2-19	Protects the range II servo amplifier and relays.
RANGE II 28VDC	Lamp	70A14	2-19	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the range II servo drives into its stop.
IRIS 28VDC	.75A Fuse	70A14	2-19	Protects the iris servo amplifier and relays.
IRIS 28VDC	Lamp	70A14	2-19	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the iris servo drives into its stop.

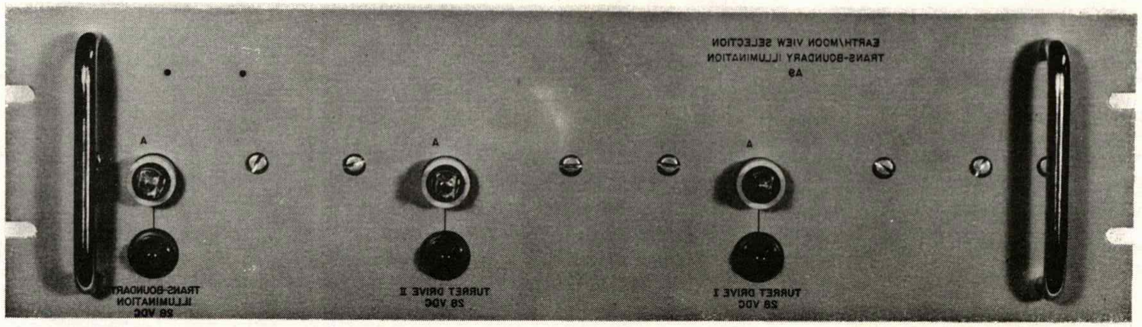


VSM2-20

Figure 2-20. Unit 70A15 Earth/Moon Illumination Terminator

Table 2-21. Unit 70A15 Earth/Moon Illumination Terminator/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
ILLUMINATION I 28VDC	1A Fuse	70A15	2-20	Protects the illumination I servo amplifier and relays.
ILLUMINATION I 28VDC	Lamp	70A15	2-20	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the illumination I servo drives into its stop.
ILLUMINATION II 28VDC	1A Fuse	70A15	2-20	Protects the illumination II servo amplifier and relays.
ILLUMINATION II 28VDC	Lamp	70A15	2-20	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the illumination II servo drives into its stop.
TERMINATOR 28VDC	1A Fuse	70A15	2-20	Protects the terminator servo amplifier and relays.
TERMINATOR 28VDC	Lamp	70A15	2-20	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the terminator servo drives into its stop.



VSM2-21

Figure 2-21. Unit 70A9 Earth/Moon View Selection Transboundary Illumination

Table 2-22. Unit 70A9 Earth/Moon View Selection Transboundary Illumination /Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
TURRET DRIVE I 28VDC	1.5A Fuse	70A9	2-21	Protects the turret drive I servo amplifier and relays.
TURRET DRIVE I 28VDC	Lamp	70A9	2-21	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the turret drive I servo drives into its stop.
TURRET DRIVE II 28VDC	1.5A Fuse	70A9	2-21	Protects the turret drive II servo amplifier and relays.
TURRET DRIVE II 28VDC	Lamp	70A9	2-21	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the turret drive II servo drives into its stop.
TRANSBOUNDARY ILLUMINATION 28VDC	1A Fuse	70A9	2-21	Protects the transboundary illumination servo amplifier and relays.
TRANSBOUNDARY ILLUMINATION 28VDC	Lamp	70A9	2-21	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the transboundary illumination servo drives into its stop.

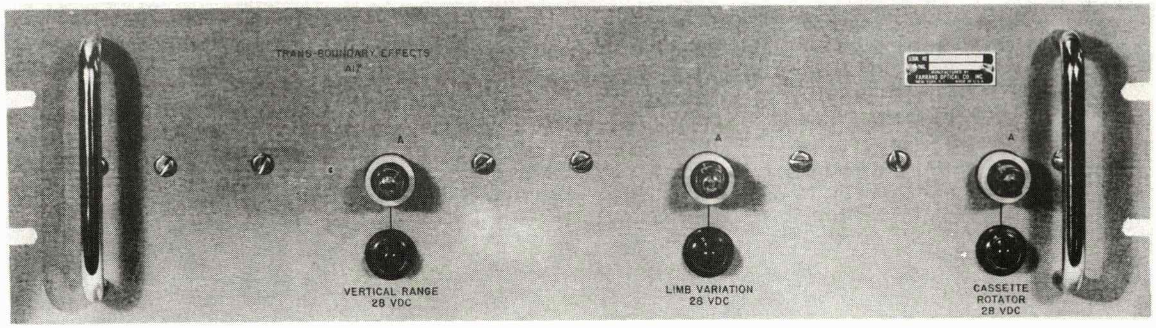
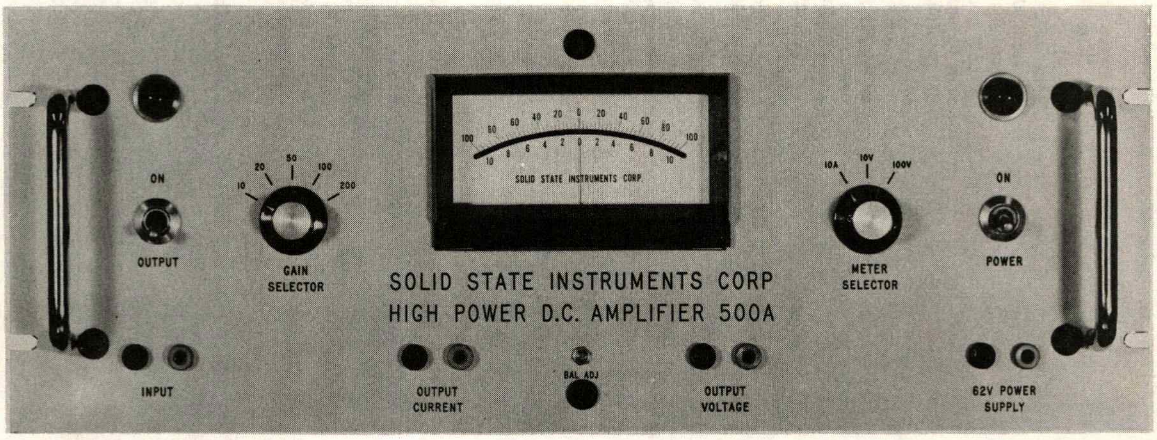


Figure 2-22. Unit 70A17 Transboundary Effects

Table 2-23. Unit 70A17 Transboundary Effects/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
VERTICAL RANGE 28VDC	1.5A Fuse	70A17	2-22	Protects the vertical range servo amplifier and relays.
VERTICAL RANGE 28VDC	Lamp	70A17	2-22	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the vertical range servo drives into its stop.
LIMB VARIATION 28VDC	1.5A Fuse	70A17	2-22	Protects the limb variation servo amplifier and relays.
LIMB VARIATION 28VDC	Lamp	70A17	2-22	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the limb variation servo drives into its stop.
CASSETTE ROTATOR 28VDC	1A Fuse	70A17	2-22	Protects the cassette rotator servo amplifier and relays.
CASSETTE ROTATOR 28VDC	Lamp	70A17	2-22	Normally illuminated when 28 volts dc is applied to the unit. Extinguishes when the cassette rotator servo drives into its stop



VSM2-23

Figure 2-23. Unit 70A2 SSI Power Amplifier

Table 2-24. Unit 70A2 SSI Power Amplifier/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
Lamp	Lamp	70A2	2-23	Indicates when the load is connected to the amplifier.
OUTPUT	Switch	70A2	2-23	The output switch connects the load to the output of the amplifier.
GAIN SELECTOR	Control	70A2	2-23	Sets the gain of the amplifier in five steps: 10, 20, 50, 100, and 200. Because of the gain-bandwidth characteristic of the amplifier, the frequency response is inversely proportional to the amplifier gain. The gain selector controls the bandwidth as well as the gain of the amplifier.
Meter	Meter	70A2	2-23	Indicates the load voltage or load current as selected by the METER SELECTOR switch. The d-c meter responds only to the average value of the input signal and, therefore, cannot be used for a-c applications or for measuring complex wave forms.
METER SELECTOR	Switch	70A2	2-23	Sets the front panel meter for the following ranges: 10 amps, 10 volts dc, 100 volts dc.
POWER ON	Switch	70A2	2-23	Controls the 115 volts ac line power to the amplifier. This switch is a circuit breaker which limits the a-c power supply current to 15 amperes. Reset is automatically accomplished by returning the switch to the "ON" position.
Lamp	Lamp	70A2	2-23	Indicates when a-c power is applied.
INPUT	Test Jacks	70A2	2-23	The black test point connects to the signal ground. The red test point connects to the high side of the input signal.
OUTPUT CURRENT	Test Jacks	70A2	2-23	The black test point is connected to the 0.05 ohm current sampling resistor network and is also connected in common with the black test point of the output voltage. The red test point is connected to the other end of the 0.05 ohm sampling resistor in series with the OUTPUT bus wire. This provides an output voltage indication of 1/20 volt-per-ampere. There are 10K "resistors" connected in series with the test points to prevent accidental short circuits in making measurements.
BAL. ADJ.	Screwdriver Adjustment	70A2	2-23	Controls the output balance.
OUTPUT VOLTAGE	Test Jacks	70A2	2-23	The black test point is connected to the OUTPUT line. The red test point is connected to the Output 1 terminal. There are 10K ohm resistors in series with these test points.
62V POWER SUPPLY	Test Jacks	70A2	2-23	The black test point goes to the -31 volt side of the power supply. The red test point goes to the +31 volt side of the power supply. There are 10K ohm resistors in series with these test points.

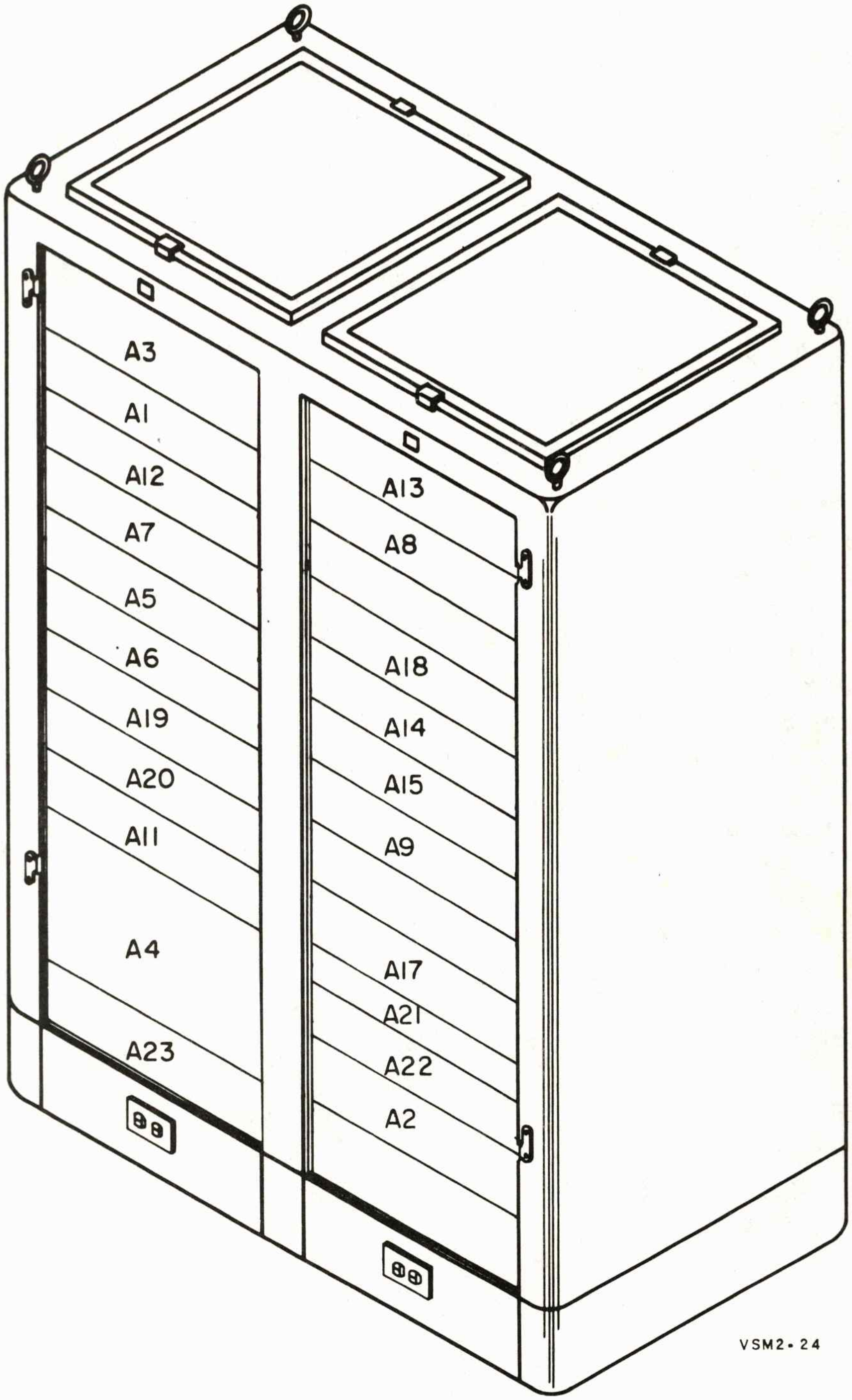


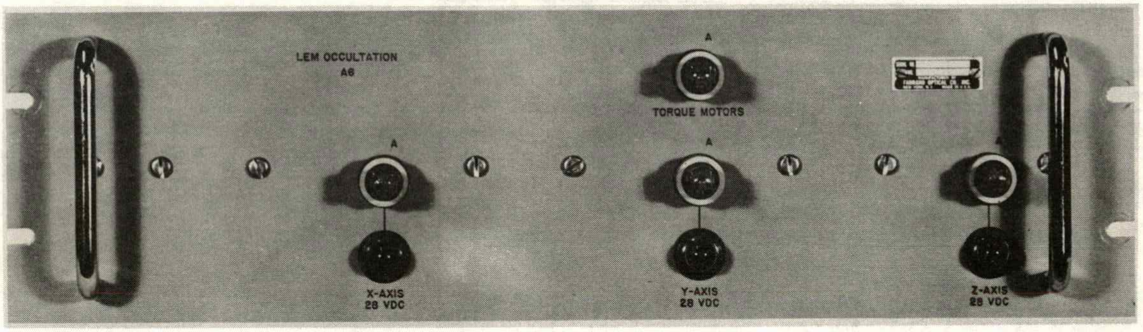
Figure 2-24. Units 72 and 73

Table 2-25. Unit 72 and Unit 73 Equipment Cabinets/Location of Panels (See figure 2-24)

Unit No.	Name	For Detail See Table No.	Figure No.	Same as
72A3	Control Panel	2-17	2-10	70A3
72A1	Celestial Sphere Electronics	2-18	2-11	70A1
72A12	Off-Course	2-19	2-12	70A12
72A7	Solar Image	2-20	2-13	70A7
72A5	Earth/Moon Occultation	2-21	2-14	70A5
72A6	LEM Ocultation	2-35	2-28	
72A19	Test Panel I	2-36	2-29	
72A20	Test Panel II	2-23	2-16	70A20
72A11	Attitude	2-24	2-17	70A11
72A4	Power Supply	2-56	2-47	6A1A2
72A23	Fuse Panel	2-25	2-18	70A23
72A13	Special Effects Terminator Inclinator	2-26	2-19	70A13
72A8	Orbital View	2-27	2-29	70A8
72A18	Trans Earth/Lunar View, Transboundary View	2-28	2-21	70A18
72A14	Vertical Range	2-29	2-22	70A14
72A15	Earth/Moon Illumination Terminator	2-30	2-23	70A15
72A9	Earth/Moon View Selection, Transboundary Illumination	2-31	2-24	70A9
72A17	Transboundary Illumination	2-32	2-25	70A17
72A21	Power Supply	2-58	2-49	6A1A6
72A22	Power Supply	2-58	2-49	6A1A6
72A2	SSI Power Amplifier	2-33	2-26	70A2
73A3	Control Panel	2-17	2-10	70A3
73A1	Celestial Sphere Electronics	2-18	2-11	70A1
73A12	Off-Course	2-19	2-12	70A12
73A7	Solar Image	2-20	2-13	70A7
73A5	Earth/Moon Occultation	2-21	2-14	70A5
73A6	LEM Occultation	2-35	2-28	72A6
73A19	Test Panel I	2-36	2-29	72A19
73A20	Test Panel II	2-23	2-16	70A20

Table 2-25. Unit 72 and Unit 73 Equipment Cabinets/Location of Panels (See figure 2-24) (Cont)

Unit No.	Name	For Detail See Table No.	Figure No.	Same as
73A11	Attitude	2-24	2-17	70A11
73A4	Power Supply	2-56	2-47	6A1A2
73A23	Fuse Panel	2-25	2-18	70A23
73A13	Special Effects Terminator Inclinator	2-26	2-19	70A13
73A8	Orbital View	2-27	2-20	70A8
73A18	Trans Earth/Lunar View, Transboundary View	2-28	2-21	70A18
73A14	Vertical Range	2-29	2-22	70A14
73A15	Earth/Moon Illumination Terminator	2-30	2-23	70A15
73A9	Earth/Moon View Selection Transboundary Illumination	2-31	2-24	70A9
73A17	Transboundary Illumination	2-32	2-25	70A17
73A21	Power Supply	2-56	2-49	6A1A6
73A22	Power Supply	2-56	2-49	6A1A6
73A2	SSI Power Amplifier	2-33	2-26	70A2



VSM2-2

Figure 2-25. Unit 72A6 LEM Occultation

Table 2-26. Unit 72A6 LEM Occultation/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
X AXIS				
Fuse	Fuse	72A6	2-25	Protects X axis 28 volt power.
Lamp	Lamp	72A6	2-25	Indicates when the X axis servo drives into its stop.
Y AXIS				
Fuse	Fuse	72A6	2-25	Protects Y axis 28 volt power.
Lamp	Lamp	72A6	2-25	Indicates when the Y axis servo drives into its stop.
Z AXIS				
Fuse	Fuse	72A6	2-25	Protects Z axis 28 volt power.
Lamp	Lamp	72A6	2-25	Indicates when the Z axis servo drives into its stop.

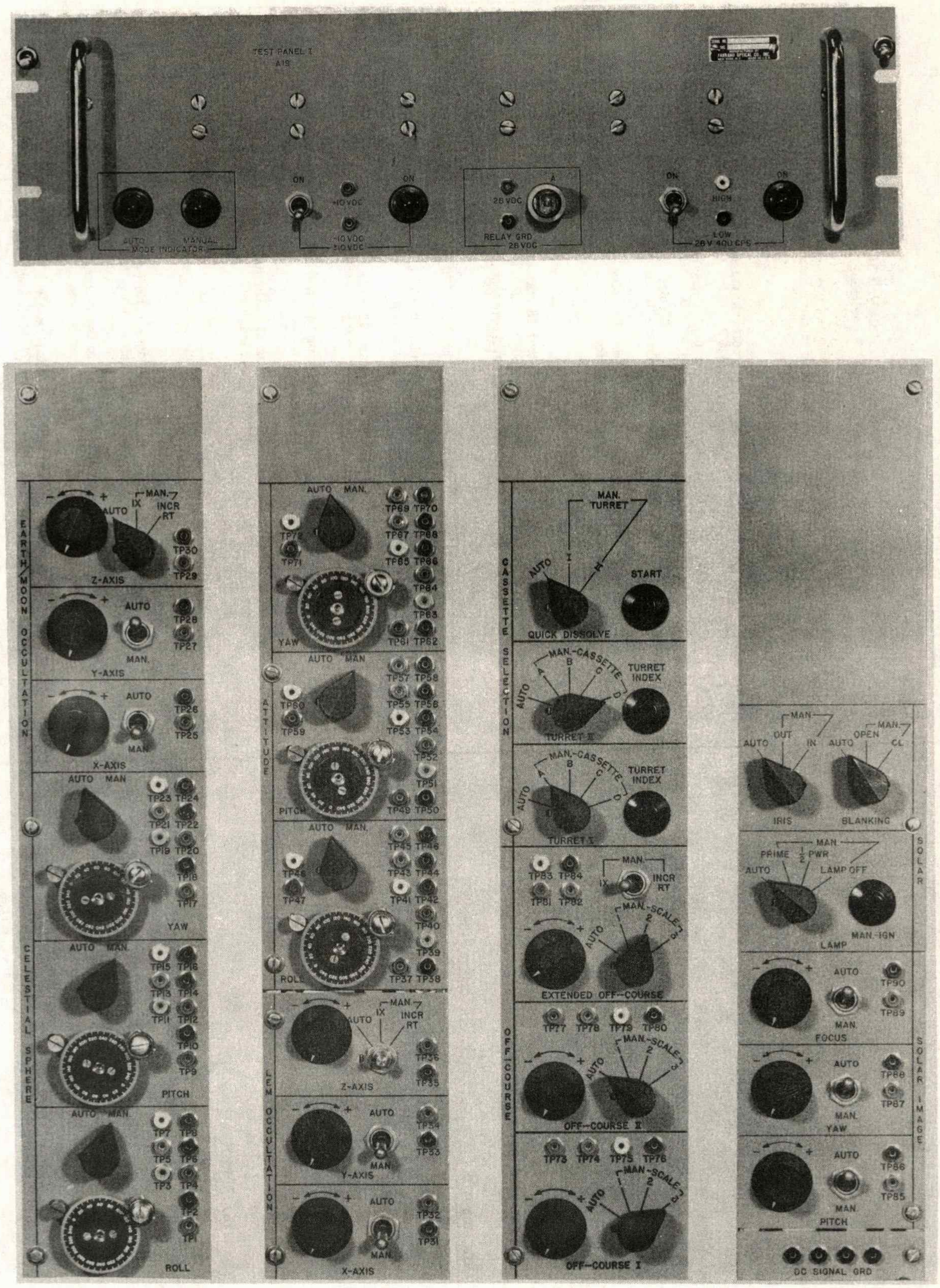


Figure 2-26. Unit 72A19 Test Panel I

VSM2-26

Table 2-27. Unit 72A19 Test Panel I/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MODE INDICATOR				
AUTO	Lamp	72A19	2-26	Indicates when all Unit 70 Auto/Man test switches are in the "AUTO" position.
MANUAL	Lamp	72A19	2-26	Indicates when any one of the Unit 70 Auto/Man test switches are in the manual position.
±10VDC				
ON	Toggle Switch	72A19	2-26	Applies ±10 volts dc reference voltage to the test potentiometers.
+10VDC	Test Jack	72A19	2-26	Used to monitor +10 volts dc reference voltage.
-10VDC	Test Jack	72A19	2-26	Used to monitor -10 volts dc reference voltage.
ON	Lamp	72A19	2-26	Indicates when ±10 volts dc "ON" Toggle switch is in the ON position.
28VDC				
28VDC	Test Jack	72A19	2-26	Used to monitor 28 volts dc relay voltage.
RELAY GRD	Test Jack	72A19	2-26	Used as ground reference when monitoring 28 volts dc.
26VDC 400 CPS				
ON	Toggle Switch	72A19	2-26	Applies 26 volts dc 400 cps excitation voltage to rotor of the test resolvers.
HIGH	Test Jack	72A19	2-26	Used to monitor 26 volts 400 cps rotor excitation voltage.
LOW	Test Jack	72A19	2-26	Used to monitor 26 volts 400 cps rotor excitation voltage.
ON	Lamp	72A19	2-26	Indicates when 26 volts 400 cps ON toggle switch is in the "ON" position.
CELESTIAL SPHERE				
ROLL				
Resolver	Resolver	72A19	2-26	Resolver drives the Roll servo when the ATUO/MAN selector switch is in the MAN position.
AUTO/MAN	Selector Switch	72A19	2-26	Selects input to the roll servo; either computer input (AUTO) or resolver input (MAN).
TP1	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP2	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S3 when the AUTO/MAN switch is in the "MAN" position.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP3	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP4	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP5	Test Jack	72A19	2-26	Used to monitor computer input to roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP6	Test Jack	72A19	2-26	Used to monitor the computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP7	Test Jack	72A19	2-26	Used to monitor the computer input to the roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP8	Test Jack	72A19	2-26	Used to monitor the computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
PITCH				
Resolver	Resolver	72A19	2-26	Resolver drives the pitch servo when the AUTO/MAN selector switch is in the MAN position.
AUTO/MAN	Selector Switch	72A19	2-26	Selects input to the pitch servo; either computer input (AUTO) or resolver input (MAN).
TP9	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP10	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP11	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP12	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP13	Test Jack	72A19	2-26	Used to monitor computer input to pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP14	Test Jack	72A19	2-26	Used to monitor the computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP15	Test Jack	72A19	2-26	Used to monitor the computer input to the pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP16	Test Jack	72A19	2-26	Used to monitor the computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
YAW				
Resolver	Resolver	72A19	2-26	Resolver drives the yaw servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	72A19	2-26	Selects input to the yaw servo; either computer input (AUTO) or resolver input (MAN).
TP17	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP18	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP19	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP20	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S4 when the ATUO/MAN switch is in the "MAN" position.
TP21	Test Jack	72A19	2-26	Used to monitor input to yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP22	Test Jack	72A19	2-26	Used to monitor the computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP23	Test Jack	72A19	2-26	Used to monitor the computer input to the yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP24	Test Jack	72A19	2-26	Used to monitor the computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
EARTH/MOON OCCULTATION				
X AXIS				
Potentiometer	Potentiometer	72A19	2-26	Controls the earth/moon occultation X axis servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	72A19	2-26	Selects input to the X axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP25	Test Jack	72A19	2-26	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP25 and dc signal ground test jacks located at front right corner of the A19 test panel.
TP26	Test Jack	72A19	2-26	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP26 and dc signal ground test jack located at the front right corner of the A19 test panel.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
Y AXIS				
Potentiometer	Potentiometer	72A19	2-26	Controls the earth/moon occultation Y axis servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	72A19	2-26	Selects input to the Y axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP27	Test Jack	72A19	2-26	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP27 and dc signal ground test jacks located at front right corner of the A19 test panel.
TP28	Test Jack	72A19	2-26	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP28 and dc signal ground test jack located at the front right corner of the A19 test panel.
Z AXIS				
Potentiometer	Potentiometer	72A19	2-26	Controls windup of Earth/Moon Occultation tape when AUTO/MAN (1X/INCR RT) switch is in either the manual "1X" or manual "INCR RT" position.
AUTO/MAN (1X/INCR RT)	Three Position Selector Switch	72A19	2-26	Selects input to the servo controlling the earth/moon occultation tape; selects computer control, 1X manual (one turn of pot to one revolution of servo) control or INCR RT (one turn of pot turns servo greater than one turn) control.
TP29	Test Jack	72A19	2-26	Used to measure the computer input to the earth/moon occultation servo when the AUTO/MAN switch is in the "AUTO" position.
TP30	Test Jack	72A19	2-26	Used to measure the manual input to the earth/moon occultation servo when the AUTO/MAN switch is in either of the manual positions.
LEM OCCULTATION				
X AXIS				
Potentiometer	Potentiometer	72A19	2-26	Controls the LEM occultation X axis servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	72A19	2-26	Selects input to the X axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP31	Test Jack	72A19	2-26	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP31 and dc signal ground test jacks located at front right corner of the A19 test panel.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP32	Test Jack	72A19	2-26	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP32 and dc signal ground test jack located at the front right corner of the A19 test panel.
Y AXIS				
Potentiometer	Potentiometer	72A19	2-26	Controls the LEM occultation Y axis servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	72A19	2-26	Selects input to the Y axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP33	Test Jack	72A19	2-26	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP33 and dc signal ground test jacks located at front right corner of the A19 test panel.
TP34	Test Jack	72A19	2-26	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP34 and dc signal ground test jack located at the front right corner of the A19 test panel.
Z AXIS				
Potentiometer	Potentiometer	72A19	2-26	Controls windup of LEM Occultation tape when AUTO/MAN (1X/INCR RT) switch is in either the manual "1X" or manual "INCR RT" position.
AUTO/MAN (1X/INCR RT)	Three Position Selector Switch	72A19	2-26	Selects input to the servo controlling the LEM occultation tape; selects computer control, 1X manual (one turn of pot to one revolution of servo) control or INCR RT (one turn of pot turns servo greater than one turn) control.
TP35	Test Jack	72A19	2-26	Used to measure the computer input to the earth/moon occultation servo when the AUTO/MAN switch is in the "AUTO" position.
TP36	Test Jack	72A19	2-26	Used to measure the manual input to the earth/moon occultation servo when the AUTO/MAN switch is in either of the manual positions.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
ATTITUDE				
ROLL				
Resolver	Resolver	72A19	2-26	Resolver drives the Roll servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	72A19	2-26	Selects input to the roll servo; either two speed computer input (AUTO) or resolver input (MAN).
TP37	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP38	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP39	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP40	Test Jack	72A19	2-26	Used to monitor resolver input to roll servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP41	Test Jack	72A19	2-26	Used to monitor the 16X computer input to roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP42	Test Jack	72A19	2-26	Used to monitor the 16X computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP43	Test Jack	72A19	2-26	Used to monitor the 16X computer input to the roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP44	Test Jack	72A19	2-26	Used to monitor the 16X computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP45	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP46	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP47	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP48	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
PITCH				
Resolver	Resolver	72A19	2-26	Resolver drives the pitch servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	72A19	2-26	Selects input to the pitch servo; either two speed computer input (AUTO) or resolver input (MAN).
TP49	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP50	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP51	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP52	Test Jack	72A19	2-26	Used to monitor resolver input to pitch servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP53	Test Jack	72A19	2-26	Used to monitor the 8X computer input to pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP54	Test Jack	72A19	2-26	Used to monitor the 8X computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP55	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP56	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP57	Test Jack	72A19	2-26	Used to monitor the 8X computer input to the pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP58	Test Jack	72A19	2-26	Used to monitor the 8X computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP59	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP60	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
YAW				
Resolver	Resolver	72A19	2-26	Resolver drives the yaw servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	72A19	2-26	Selects inputs to the yaw servo; either two speed computer input (AUTO) or resolver input (MAN).
TP61	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP62	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP63	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP64	Test Jack	72A19	2-26	Used to monitor resolver input to yaw servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP65	Test Jack	72A19	2-26	Used to monitor the 8X computer input to yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP66	Test Jack	72A19	2-26	Used to monitor the 8X computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP67	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP68	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP69	Test Jack	72A19	2-26	Used to monitor the 8X computer input to the yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP70	Test Jack	72A19	2-26	Used to monitor the 8X computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP71	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP72	Test Jack	72A19	2-26	Used to monitor the 1X computer input to the yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
OFF COURSE				
OFF COURSE I				
Potentiometer	Potentiometer	72A19	2-26	Controls the off course I potentiometer when the AUTO/MAN switch is in any one of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	72A19	2-26	Select input to the off course servo I; Auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.
TP73	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 1. Measured between TP73 and dc signal ground test jacks, located on front right of A19 test panel.
TP74	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 2. Measured between TP73 and dc signal ground test jacks, located on front right of A19 test panel.
TP75	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 3. Measured between TP74 and d-c signal ground, located on front right of A19 test panel.
TP76	Test Jack	72A19	2-26	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP76 and d-c signal ground located on front right of A19 test panel.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
OFF COURSE II				
Potentiometer	Potentiometer	72A19	2-26	Controls the off course II servo when the AUTO/MAN switch is in any of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	72A19	2-26	Select inout to the off course servo II; Auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.
TP77	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 1. Measured between TP77 and d-c signal ground test jacks, located on front right of A19 test panel.
TP78	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 2. Measured between TP78 and d-c signal ground test jacks, located on front right of A19 test panel.
TP79	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 3. Measured between TP79 and d-c signal ground, located on front right of A19 test panel.
TP80	Test Jack	72A19	2-26	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP80 and d-c signal ground located on front right of A19 test panel.
EXTENDED OFF-COURSE				
Potentiometer	Potentiometer	72A19	2-26	Controls the extended off course servo when the AUTO/MAN switch is in any one of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	72A19	2-26	Select input to the extended off course servo; auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, 3 simulate the three computer inputs to the servo.
MAN-(1X/INCR RT)	Toggle Switch	72A19	2-26	Allows the manual control potentiometer to drive the extended off course servo at a 1 to 1 rate or, at a greater than 1 to 1 rate.
TP81	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 1. Measured between TP81 and d-c signal ground test jacks, located on front right of A19 test panel.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP82	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 2. Measured between TP82 and d-c signal ground test jacks, located on front right of A19 test panel.
TP83	Test Jack	72A19	2-26	Used to monitor automatic input signals from computer in mode 3. Measured between TP83 and d-c signal ground, located on front right of A19 test panel.
TP84	Test Jack	72A19	2-26	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP84 and d-c signal ground located on front right of A19 test panel.
CASSETTE SECTION				
TURRET I				
AUTO/MAN CASSETTE (ABCD)	Four Position Selector Switch	72A19	2-26	Selects computer control or manual control. In manual control, positions A, B, C, and D are the various positions for setting the turret. The turret will not respond in any manual position until the turret index button is pressed.
TURRET INDEX	Push Button	72A19	2-26	Prevents turret from turning when AUTO/MAN switch is shifted from position to position. Turret will not move in manual control until this button is pressed.
TURRET II				
AUTO/MAN CASSETTE (ABCD)	Four Position Selector Switch	72A19	2-26	Selects computer control or manual control. In manual control, positions A, B, C, and D are the various positions for setting the turret. The turret will not respond in any manual position until the turret index button is pressed.
TURRET INDEX	Push Button	72A19	2-26	Prevents turret from turning when AUTO/MAN switch is shifted from position to position. Turret will not move in manual control until this button is pressed.
QUICK DISSOLVE				
AUTO MAN (I II)	Three Position Selector Switch	72A19	2-26	Selects input control signals for the quick dissolve servo; Computer control (auto), or Manual input I or II.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
START	Push Button	72A19	2-26	Prevents quick dissolve servos from turning when the AUTO/MAN switch is turned from position to position. In the manual mode this button must be pushed to cause the servo to drive.
DC SIGNAL GRD				
Four Test Jacks	Test Jack	72A19	2-26	Used as a ground reference when measuring between ground and d-c test jacks in the A19 test panel. All four test jacks are common.
SOLAR IMAGE				
PITCH				
Potentiometer	Potentoimeter	72A19	2-26	Controls the solar image servo in the pitch axis when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	72A19	2-26	Selects input to the pitch axis servo; either computer input (auto) or potentiometer input (MAN).
TP85	Test Jack	72A19	2-26	Used to monitor the computer input when the AUTO/MAN switch is in the automatic position. Reading is taken between TP85 and d-c signal ground located at the front right corner of the A19 test panel.
TP86	Test Jack	72A19	2-26	Used to monitor the manual input potentiometer when the AUTO/MANUAL switch is in the manual position. Reading is taken between TP86 and d-c signal ground located at the right front corner of the A19 test panel.
YAW				
Potentiometer	Potentiometer	72A19	2-26	Controls the solar image servo in the yaw axis when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	72A19	2-26	Selects input to the yaw axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP87	Test Jack	72A19	2-26	Used to monitor the computer input when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP87 and d-c signal ground located at the front right corner of the A19 test panel.
TP88	Test Jack	72A19	2-26	Used to monitor the manual input from potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP88 and d-c signal ground located at the right front corner of the A19 test panel.

Table 2-27. Unit 72A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
FOCUS				
Potentiometer	Potentiometer	72A19	2-26	Controls the solar image focus servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	72A19	2-26	Selects input to the focus servo; either computer input (AUTO) or potentiometer input (MAN).
TP89	Test Jack	72A19	2-26	Used to monitor the computer input when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP89 and d-c signal ground located at the front right corner of the A19 test panel.
TP90	Test Jack	72A19	2-26	Used to monitor the manual input potentiometer when the AUTO/MANUAL switch is in the "MAN" position. Reading is taken between TP90 and d-c signal ground located at the right front corner of the A19 test panel.
SOLAR				
LAMP				
AUTO/MAN (PRIME-1/2PWR-LAMP OFF)	Four Position Selector Switch	72A19	2-26	Selects control for the Solar lamp as follows: AUTO; computer control MAN/PRIME; full manual lamp power controlled by test panel A19 MAN/1/2PWR; 1/2 manual lamp power controlled by test panel A19 MAN/LAMP OFF; lamp secured under control of test panel A19
MAN/IGN	Push Button	72A19	2-26	Starts lamp when AUTO/MANUAL selector switch is in MAN /PRIME position.
IRIS/BLANKING				
IRIS-AUTO/MAN (OUT-IN)	Three Position Selector Switch	72A19	2-26	Selects control for solar iris as follows: AUTO; computer control MAN/OUT; iris is moved into lamp under manual control MAN/IN; iris moved into lamp under manual control
BLANKING-AUTO/MAN	Three Position Selector Switch	72A19	2-26	Selects control for blanking shutter as follows: AUTO; computer control MAN/OPEN; blanking shutter open under manual control MAN/CL; blanking shutter closed under manual control

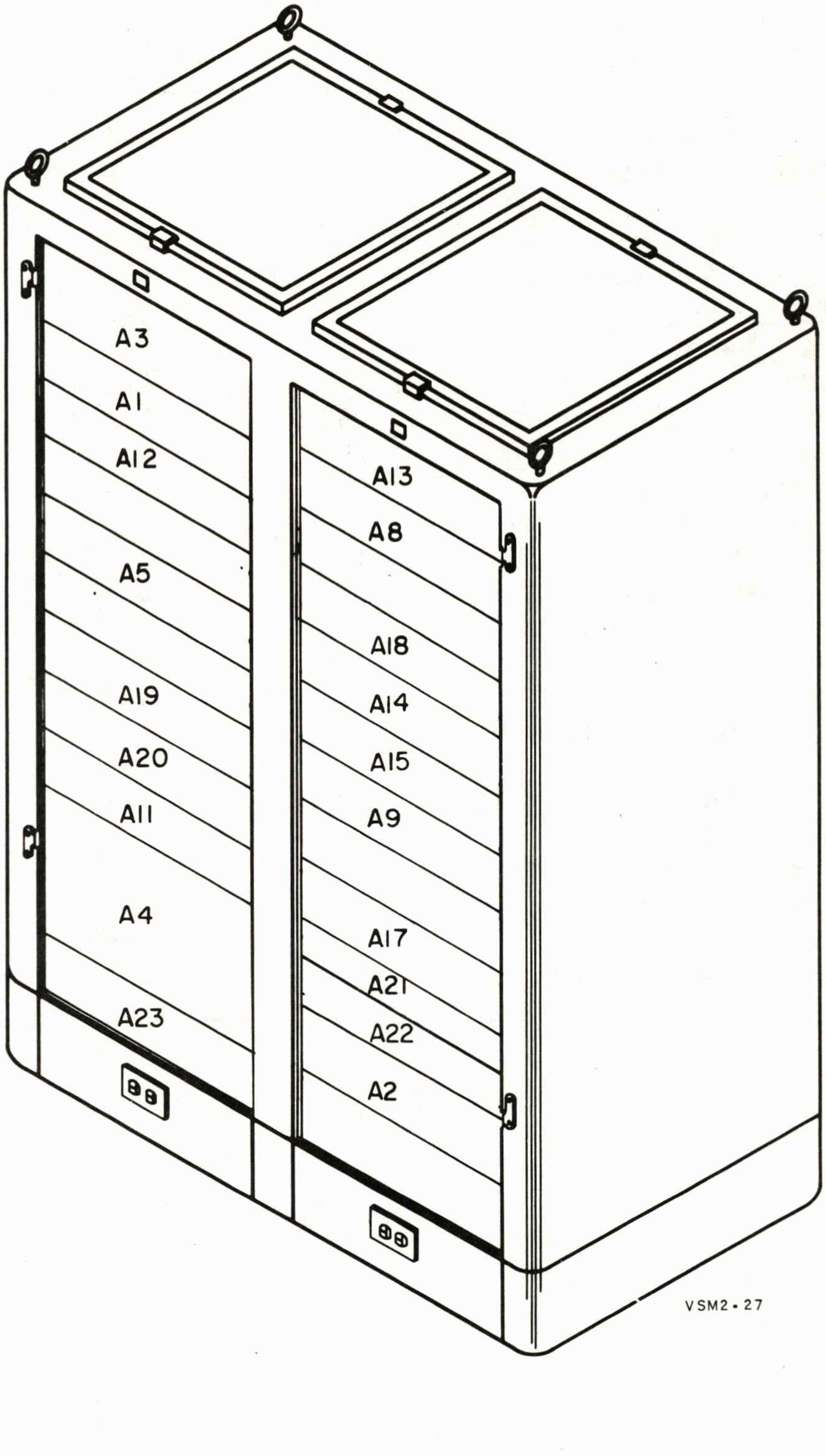


Figure 2-27. Unit 10

Table 2-28. Unit 10 Equipment Cabinet/Location of Panels (See figure 2-27)

Unit No.	Name	For Detail See Table No.	Figure No.	Same as
10A3	Control Panel	2-29	2-28	
10A1	Celestial Sphere Electronics	2-9	2-8	70A1
10A12	Off Course	2-10	2-9	70A12
10A5	Earth/Moon Occultation	2-11	2-10	70A5
10A19	Test Panel I	2-30	2-29	
10A20	Test Panel II	2-14	2-13	70A20
10A11	Attitude	2-15	2-14	70A11
10A4	Power Supply	2-45	2-44	6A1A2
10A23	Fuse Panel	2-16	2-15	70A23
10A13	Special Effects Terminator Inclinator	2-17	2-16	
10A8	Orbital View	2-18	2-17	70A8
10A18	Trans Earth/Lunar View, Transboundary View	2-19	2-18	70A18
10A14	Vertical Range	2-20	2-19	70A14
10A15	Earth/Moon Illumination Terminator	2-21	2-20	70A15
10A9	Earth/Moon Transboundary Illuminator	2-22	2-21	70A9
10A17	Transboundary Effects	2-23	2-23	70A17
10A21	Power Supply	2-47	2-46	6A1A6
10A22	Power Supply	2-47	2-46	6A1A6
10A2	SSI Power Amplifier	2-24	2-23	70A2

Table 2-29. Unit 10A3 Control Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
CELESTIAL SPHERE ILLUMINATION				
120/208V 60CPS 30 POWER-ON	Toggle Switch	10A3	2-28	Picks up control relay that applies 208 volts to celestial sphere lamp through the variable LAMP VOLTAGE CONTROL transformer.
Lamp	Lamp	10A3	2-28	Indicates when the 120/208V 60CPS 30 power-on switch is in the "ON" position.
Fuse	Fuse	10A3	2-28	Provedes protection for the 120/208 volt power-on circuits.
LAMP START	Push button	10A3	2-28	Excites the celestial sphere arc-lamp igniter and causes the lamp to ignite.
LAMP ELAPSED TIME	Meter	10A3	2-28	Indicates operating hours on celestial sphere lamp.
LAMP CURRENT	Meter	10A3	2-28	Indicates current being drawn by the celestial sphere lamp.
LAMP VOLTAGE CONTROL	Variable Transformer	10A3	2-28	Controls voltage being applied to the celestial sphere lamp from the 208 volt power source. Voltage can be increased or decreased by varying the transformer control knob.
ON 120/208V 60CPS 30	Toggle Switch	10A3	2-28	Picks up control relay that applies 120V/208V 60CPS 30 power to the start button.
START	Push button	10A3	2-28	Applies 120/208V 60CPS 30 power to the entire cabinet.
Lamp	Lamp	10A3	2-28	Indicates when 120/208V 60CPS 30 power has been applied to the cabinet.
ELAPSED TIME	Meter	10A3	2-28	Indicates operating hours for the cabinet.
115V 400CPS/ON	Toggle Switch	10A3	2-28	Applies 115V 400 cps power to the entire cabinet.
Lamp	Lamp	10A3	2-28	Indicates when 115V 400 cps power switch is in the "ON" position.
5A Fuse	Fuse	10A3	2-28	Protects the 115V 400 cps circuit.
Lamp	Lamp	10A3	2-28	Indicates when the 120V 60CPS 10 power is available at the convenience outlet located at the bottom of the cabinet.
15A Fuse	Fuse	10A3	2-28	Provides protection for the 115 volt convenience outlet.

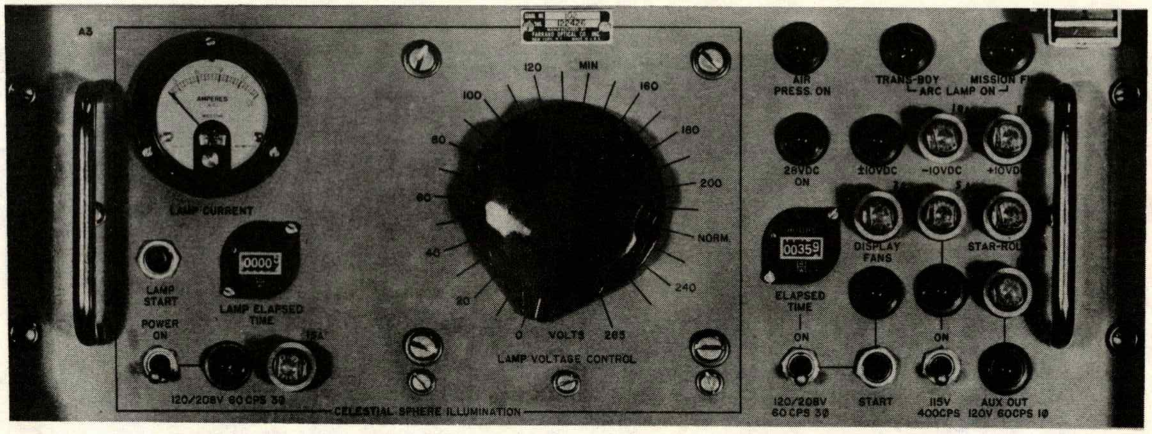


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Figure 2-28. Unit 10A3 Control Panel

Table 2-29. Unit 10A3 Control Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
2A/DISPLAY FANS	Fuse	10A3	2-28	Provides protection for the cooling fans located in the MEP.
10A/STAR ROLL PA	Fuse	10A3	2-28	Provides protection for the celestial sphere roll-axis power amplifier.
28VDC ON	Lamp	10A3	2-28	Indicates when 28 vdc is applied to the cabinet.
±10VDC	Lamp	10A3	2-28	Indicates when ±10 volts dc is applied to the cabinet.
10A/-10VDC	Fuse	10A3	2-28	Provides protection for the -10 volts dc circuits.
10A/+10VDC	Fuse	10A3	2-28	Provides protection for the +10 volts dc circuits.
AIR PRES ON	Lamp	10A3	2-28	Indicates when power is applied to the film cooling air compressor.
ARC LAMP ON TRANS BDY	Lamp	10A3	2-28	Indicates when the Transboundary Arc Lamp has been ignited.
ARC LAMP ON MISSION FILM	Lamp	10A3	2-28	Indicates when the Mission Film Arc Lamp has been ignited.

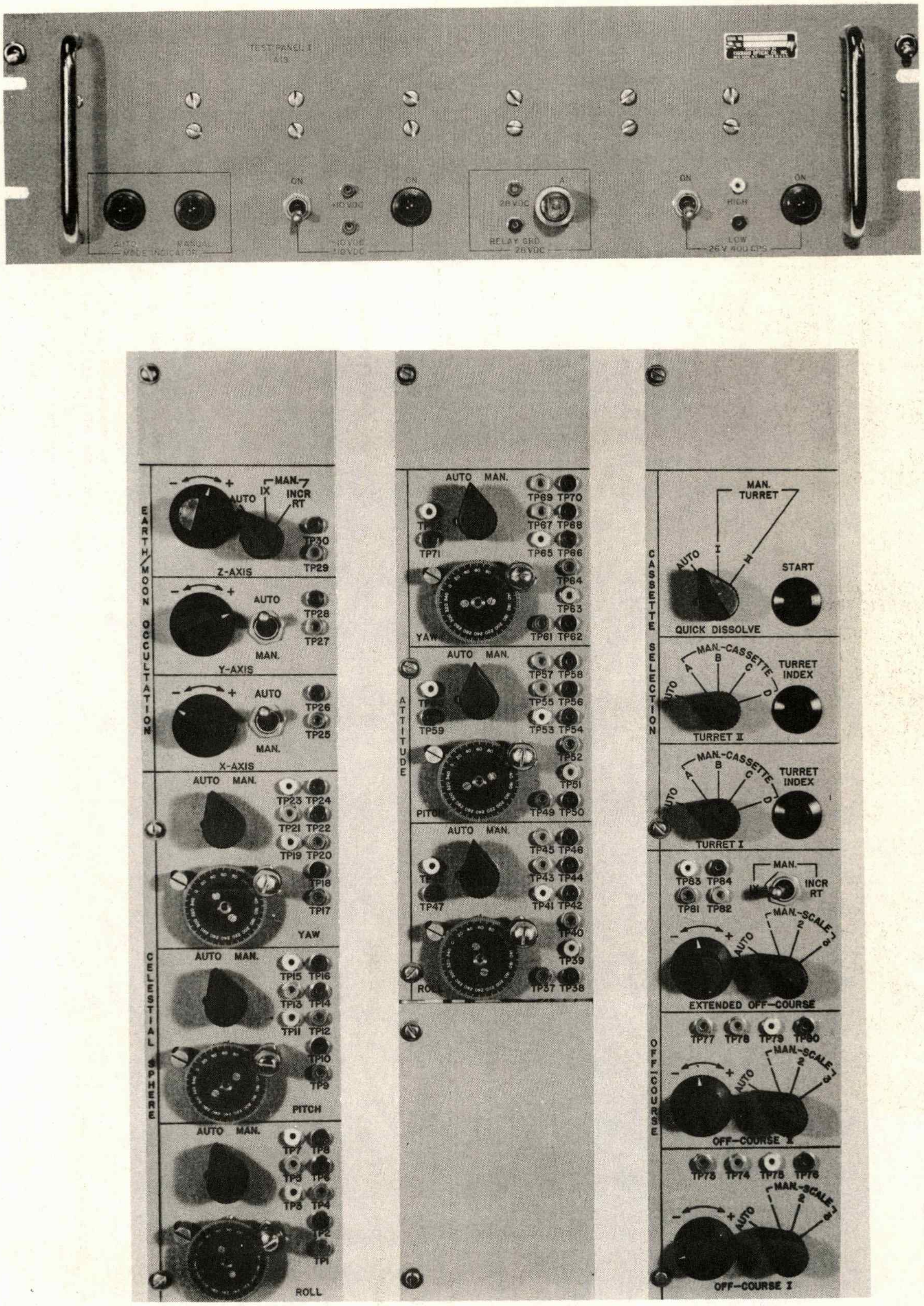

Figure 2-29. Unit 10A19 Test Panel I

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Table 2-30. Unit 10A19 Test Panel I/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MODE INDICATOR				
AUTO	Lamp	10A19	2-29	Indicates when all Unit 70 Auto/Man test switches are in the "AUTO" position.
MANUAL	Lamp	10A19	2-29	Indicates when any one of the Unit Auto/Man test switches are in the "MAN" position.
±10VDC				
ON	Toggle Switch	10A19	2-29	Applies ±10 volts dc reference voltage to the test potentiometers.
+10VDC	Test Jack	10A19	2-29	Used to monitor +10 volts dc reference voltage.
-10VDC	Test Jack	10A19	2-29	Used to monitor -10 volts dc reference voltage.
ON	Lamp	10A19	2-29	Indicates when ±10 volts dc ON toggle switch is in the "ON" position.
28VDC				
28VDC	Test Jack	10A19	2-29	Used to monitor 28 volts dc relay voltage.
RELAY GRD	Test Jack	10A19	2-29	Used as ground reference when monitoring 28 volts dc.
26VDC 400 CPS				
ON	Toggle Switch	10A19	2-29	Applies 26 volts dc 400 cps excitation voltage to rotor of the test resolvers.
High	Test Jack	10A19	2-29	Used to monitor 26 volts 400 cps rotor excitation voltage.
Low	Test Jack	10A19	2-29	Used to monitor 26 volts 400 cps rotor excitation voltage.
ON	Lamp	10A19	2-29	Indicates when 26 volts 400 cps ON toggle switch is in the "ON" position.
CELESTIAL SPHERE				
ROLL				
Resolver	Resolver	10A19	2-29	Resolver drives the Roll servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	10A19	2-29	Selects input to the roll servo; either computer input (AUTO) or resolver input (MAN).
TP1	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP2	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP3	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S2 when the AUTO/MAN switch is in the "MAN" position.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP4	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP5	Test Jack	10A19	2-29	Used to monitor computer input to roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP6	Test Jack	10A19	2-29	Used to monitor the computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP7	Test Jack	10A19	2-29	Used to monitor the computer input to the roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP8	Test Jack	10A19	2-29	Used to monitor the computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
PITCH				
Resolver	Resolver	10A19	2-29	Resolver drives the pitch servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	10A19	2-29	Selects input to the pitch servo; either computer input (AUTO) or resolver input (MAN).
TP9	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP10	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP11	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP12	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP13	Test Jack	10A19	2-29	Used to monitor computer input to pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP14	Test Jack	10A19	2-29	Used to monitor the computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP15	Test Jack	10A19	2-29	Used to monitor the computer input to the pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP16	Test Jack	10A19	2-29	Used to monitor the computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
YAW				
Resolver	Resolver	10A19	2-29	Resolver drives the yaw servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	10A19	2-29	Selects input to the yaw servo; either computer input (AUTO) or resolver input (MAN).
TP17	Test Jack	10A19	2-29	Used to monitor resolver input to yaw servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP18	Test Jack	10A19	2-29	Used to monitor resolver input to yaw servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP19	Test Jack	10A19	2-29	Used to monitor resolver input to yaw servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP20	Test Jack	10A19	2-29	Used to monitor resolver input to yaw servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP21	Test Jack	10A19	2-29	Used to monitor input to yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP22	Test Jack	10A19	2-29	Used to monitor the computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP23	Test Jack	10A19	2-29	Used to monitor the computer input to the yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP24	Test Jack	10A19	2-29	Used to monitor the computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
EARTH/MOON OCCULTATION				
X AXIS				
Potentiometer	Potentiometer	10A19	2-29	Controls the earth/moon occultation X axis servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	10A19	2-29	Selects input to the X axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP25	Test Jack	10A19	2-29	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP25 and dc signal ground test jacks located at front right corner of the A19 test panel.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP26	Test Jack	10A19	2-29	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP26 and dc signal ground test jack located at the front right corner of the A19 test panel.
Y AXIS				
Potentiometer	Potentiometer	10A19	2-29	Controls the earth/moon occultation Y axis servo when the AUTO/MAN switch is in the "MAN" position.
AUTO/MAN	Toggle Switch	10A19	2-29	Selects input to the Y axis servo; either computer input (AUTO) or potentiometer input (MAN).
TP27	Test Jack	10A19	2-29	Used to measure the input from the computer when the AUTO/MAN switch is in the "AUTO" position. Reading is taken between TP27 and dc signal ground test jacks located at front right corner of the A19 test panel.
TP28	Test Jack	10A19	2-29	Used to measure the input from the manual potentiometer when the AUTO/MAN switch is in the "MAN" position. Reading is taken between TP28 and dc signal ground test jack located at the front right corner of the A19 test panel.
Z AXIS				
Potentiometer	Potentiometer	10A19	2-29	Controls windup of Earth/Moon Occultation tape when AUTO/MAN (1X/INCR RT) switch is in either the manual "1X" or manual "INCR RT" position.
AUTO/MAN (1X/INCR RT)	Three Position Selector Switch	10A19	2-29	Selects input to the servo controlling the earth/moon occultation tape; selects computer control, 1X manual (one turn of pot to one revolution of servo) control or INCR RT (one turn of pot turns servo greater than one turn) control.
TP29	Test Jack	10A19	2-29	Used to measure the computer input to the earth/moon occultation servo when the AUTO/MAN switch is in the "AUTO" position.
TP30	Test Jack	10A19	2-29	Used to measure the manual input to the earth/moon occultation servo when the AUTO/MAN switch is in either of the manual positions.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
ATTITUDE				
ROLL				
Resolver	Resolver	10A19	2-29	Resolver drives the Roll servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	10A19	2-29	Selects input to the roll servo; either two speed computer input (AUTO) or resolver input (MAN).
TP37	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP38	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP39	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP40	Test Jack	10A19	2-29	Used to monitor resolver input to roll servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP41	Test Jack	10A19	2-29	Used to monitor the 16X computer input to roll servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP42	Test Jack	10A19	2-29	Used to monitor the 16X computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP43	Test Jack	10A19	2-29	Used to monitor the 16X computer input to the roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP44	Test Jack	10A19	2-29	Used to monitor the 16X computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP45	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the roll servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP46	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the roll servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP47	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the roll servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Fucntion
TP48	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the roll servo stator S2 when the AUTO/MAN switch is in the "AUTQ" position.
PITCH				
Resolver	Resolver	10A19	2-29	Resolver drives the pitch servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	10A19	2-29	Selects input to the pitch servo; either two speed computer input (AUTO) or resolver input (MAN).
TP49	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP50	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP51	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP52	Test Jack	10A19	2-29	Used to monitor resolver input to pitch servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP53	Test Jack	10A19	2-29	Used to monitor the 8X computer input to pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP54	Test Jack	10A19	2-29	Used to monitor the 8X computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP55	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP56	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP57	Test Jack	10A19	2-29	Used to monitor the 8X computer input to the pitch servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP58	Test Jack	10A19	2-29	Used to monitor the 8X computer input to the pitch servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP59	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the pitch servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP60	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the pitch servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
YAW				
Resolver	Resolver	10A19	2-29	Resolver drives the yaw servo when the AUTO/MAN selector switch is in the "MAN" position.
AUTO/MAN	Selector Switch	10A19	2-29	Selects inputs to the yaw servo; either two speed computer input (AUTO) or resolver input (MANUAL).
TP61	Test Jack	10A19	2-29	Used to monitor resolver input to yaw servo stator S1 when the AUTO/MAN switch is in the "MAN" position.
TP62	Test Jack	10A19	2-29	Used to monitor resolver input to yaw servo stator S3 when the AUTO/MAN switch is in the "MAN" position.
TP63	Test Jack	10A19	2-29	Used to monitor resolver input to yaw servo stator S2 when the AUTO/MAN switch is in the "MAN" position.
TP64	Test Jack	10A19	2-29	Usde to monitor resolver input to yaw servo stator S4 when the AUTO/MAN switch is in the "MAN" position.
TP65	Test Jack	10A19	2-29	Used to monitor the 8X computer input to yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
TP66	Test Jack	10A19	2-29	Used to monitor the 8X computer input to the yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP67	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP68	Test Jack	10A19	2-29	Used to mointor the 1X computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.
TP69	Test Jack	10A19	2-29	Used to monitor the 8X computer input to the yaw servo stator S1 when the AUTO/MAN switch is in the "AUTO" position.
TP70	Test Jack	10A19	2-29	Used to monitor the 8X computer input to the yaw servo stator S3 when the AUTO/MAN switch is in the "AUTO" position.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

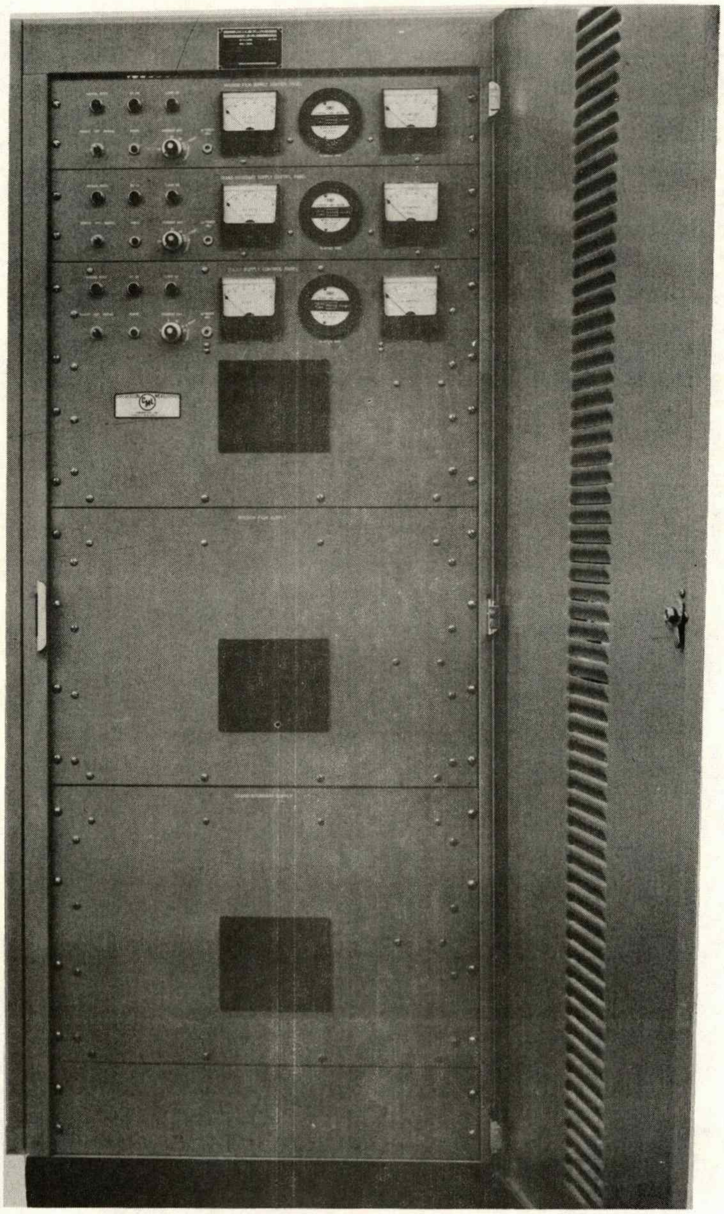
Control or Display	Description	Panel No.	Figure No.	Function
TP71	Test Jack	10A19	2-29	Used to monitor the 1X computer input to yaw servo stator S4 when the AUTO/MAN switch is in the "AUTO" position.
TP72	Test Jack	10A19	2-29	Used to monitor the 1X computer input to the yaw servo stator S2 when the AUTO/MAN switch is in the "AUTO" position.
OFF COURSE				
OFF COURSE I				
Potentiometer	Potentiometer	10A19	2-29	Controls the off course I potentiometer when the AUTO/MAN switch is in any one of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	10A19	2-29	Select input to the off course servo I; Auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.
TP73	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 1. Measured between TP73 and d-c signal ground test jacks, located on front right of A19 test panel.
TP74	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 2. Measured between TP73 and d-c signal ground test jacks, located on front right of A19 test panel.
TP75	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 3. Measured between TP74 and d-c signal ground, located on front right of A19 test panel.
TP76	Test Jack	10A19	2-29	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP76 and d-c signal ground located on front right of A19 test panel.
OFF COURSE II				
Potentiometer	Potentiometer	10A19	2-29	Controls the off course II servo when the AUTO/MAN switch is in any one of the three manaul positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	10A19	2-29	Select input to the off course servo II; Auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP77	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 1. Measured between TP77 and d-c signal ground test jacks, located on front right of A19 test panel.
TP78	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 2. Measured between TP78 and d-c signal ground test jacks, located on front right of A19 test panel.
TP79	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 3. Measured between TP79 and d-c signal ground, located on front right of A19 test panel.
TP80	Test Jack	10A19	2-29	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions. Measured between TP80 and d-c signal ground located on front right of A19 test panel.
EXTENDED OFF-COURSE				
Potentiometer	Potentiometer	10A19	2-29	Controls the extended off course servo when the AUTO/MAN switch is in any one of the three manual positions.
AUTO/MAN (1-2-3)	Four Position Selector Switch	10A19	2-29	Select input to the extended off course servo; auto position for computer signals or one of the three manual positions (1-2-3) for manual control. Positions 1, 2, and 3 simulate the three computer inputs to the servo.
MAN-(1X/INCR RT)	Toggle Switch	10A19	2-29	Allows the manual control potentiometer to drive the extended off course servo at a 1 to 1 rate or, at a greater tahn 1 to 1 rate.
TP81	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 1. Measured between TP81 and d-c signal ground test jacks, located on front right of A19 test panel.
TP82	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 2. Measured between TP82 and d-c signal ground test jacks, located on front right of A19 test panel.
TP83	Test Jack	10A19	2-29	Used to monitor automatic input signals from computer in mode 3. Measured between TP83 and d-c signal ground, located on front right of A19 test panel.

Table 2-30. Unit 10A19 Test Panel I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TP84	Test Jack	10A19	2-29	Used to measure manual input signals when the AUTO/MAN switch is in any of the three manual positions.
CASSETTE SECTION				
TURRET I				
AUTO/MAN CASSETTE (ABCD)	Four Position Selector Switch	10A19	2-29	Selects computer control or manual control. In manual control, positions A, B, C, and D are the various positions for setting the turret. The turret will not respond in any manual position until the turret index button is pressed.
TURRET INDEX	Push Button	10A19	2-29	Prevents turret from turning when AUTO/MAN switch is shifted from position to position. Turret will not move in manual control until this button is pressed.
TURRET II				
AUTO/MAN CASSETTE (ABCD)	Four Position Selector Switch	10A19	2-29	Selects computer control or manual control. In manual control, positions A, B, C, and D are the varoius positions for setting the turret. The turret will not respond in any manual position until the turret index button is pressed.
TURRET INDEX	Push Button	10A19	2-29	Prevents turret from turning when AUTO/MAN switch is shifted from position to position. Turret will not move in manual control until this button is pressed.
QUICK DISSOLVE				
AUTO MAN (I II)	Three Position Selector Switch	10A19	2-29	Selects input control signals for the quick dissolve servo; Computer control (AUTO), or Manual input I or II.
START	Push Button	10A19	2-29	Prevents quick disslove servos from turning when the AUTO/MAN switch is turned from position to position. In the manual mode this button must be pushed to cause the servo to drive.
DC SIGNAL GRD				
Four Test Jacks	Test Jacks	10A19	2-29	Used as a ground reference when measuring between ground and d-c test jacks in the A19 test panel. All four test jacks are common.



VSM2-30

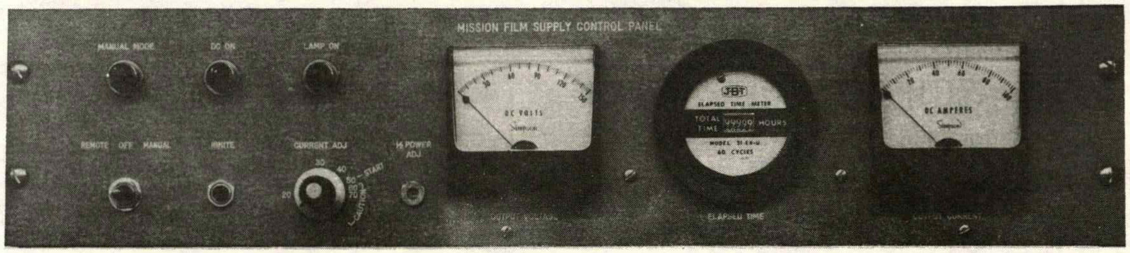
Figure 2-30. Units 88, 89, 90, 91, 92 Power Supply Cabinet

Table 2-31. Units 88, 89, 90, 91, 92 Power Supply Equipment Cabinets/Location of Panels (See figure 2-30)

Index No.	Name	For Detail See Table No.	For Detail See Figure No.	Same as
1	Mission Film Control Panel	2-32	2-31	
2	Transboundary Supply Control Panel	2-33	2-32	
3	Solar Supply Control Panel	2-34	2-33	

NOTE

Equipment cabinet Unit No. 88 does not have panel 3 Solar Supply Control Panel.

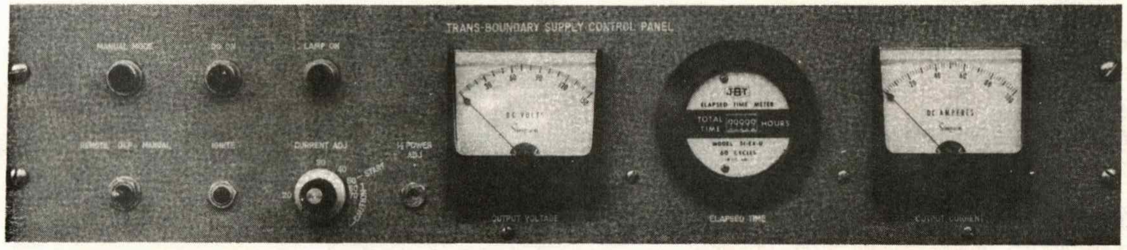


VSM2-31

Figure 2-31. Mission Film Power Supply

Table 2-32. Mission Film Power Supply/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MANUAL MODE	Indicator		2-31	Indicates power on in MANUAL mode of operation.
DC ON	Indicator		2-31	Indicates that d-c voltage is present.
LAMP ON	Indicator		2-31	Indicates that arc lamp is ignited.
REMOTE-OFF-MANUAL	Switch		2-31	Switches between REMOTE, MANUAL and OFF positions of control.
IGNITE	Switch		2-31	Provides signal to arc lamp starter.
CURRENT ADJ	Control		2-31	Adjusts current output in full power mode.
1/2 POWER ADJ	Control		2-31	Adjusts current output in 1/2 power mode.
OUTPUT VOLTAGE	Meter		2-31	Reflects output voltage of power supply.
ELAPSED TIME	Meter		2-31	Indicates hours of arc lamp operation.
OUTPUT CURRENT	Meter		2-31	Indicates output current of power supply.

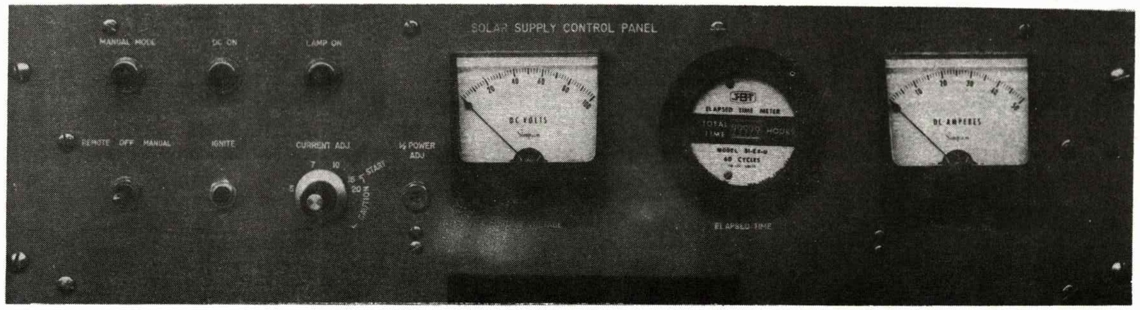


VSM2•32

Figure 2-32. 3000 Watt Transboundary Power Supply

Table 2-33. 3000 Watt Transboundary Power Supply/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MANUAL MODE	Indicator		2-32	Indicates power on in MANUAL mode of operation.
DC ON	Indicator		2-32	Indicates that d-c voltage is present.
LAMP ON	Indicator		2-32	Indicates that arc lamp is ignited.
REMOTE-OFF-MANUAL	Switch		2-32	Switches between REMOTE, MANUAL and OFF positions of control.
IGNITE	Switch		2-32	Provides signal to arc lamp starter.
CURRENT ADJ	Control		2-32	Adjusts current output in full power mode.
1/2 POWER ADJ	Control		2-32	Adjusts current output in 1/2 power mode.
OUTPUT VOLTAGE	Meter		2-32	Reflects output voltage of power supply.
ELAPSED TIME	Meter		2-32	Indicates hours of arc lamp operation.
OUTPUT CURRENT	Meter		2-32	Indicates output current of power supply.



VSM2-33

Figure 2-33. 400 Watt Solar Power Supply

Table 2-34. 400 Watt Solar Power Supply/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MANUAL MODE	Indicator		2-33	Indicates power on in MANUAL mode of operation.
DC ON	Indicator		2-33	Indicates that d-c voltage is present.
LAMP ON	Indicator		2-33	Indicates that arc lamp is ignited.
REMOTE-OFF-MANUAL	Switch		2-33	Switches between REMOTE, MANUAL and OFF positions of control.
IGNITE	Switch		2-33	Provides signal to arc lamp starter.
CURRENT ADJ	Control		2-33	Adjusts current output in full power mode.
1/2 POWER ADJ	Control		2-33	Adjusts current output in 1/2 power mode.
OUTPUT VOLTAGE	Meter		2-33	Reflects output voltage of power supply.
ELAPSED TIME	Meter		2-33	Indicates hours of arc lamp operation.
OUTPUT CURRENT	Meter		2-33	Indicates output current of power supply.

2-11. RENDEZVOUS AND DOCKING EQUIPMENT CONTROL FUNCTIONS.

2-12. The following tables list all the controls, with their functions, used on the Rendezvous and Docking Equipment Cabinets. Layout illustrations are presented for each cabinet with a table referencing each cabinet panel. Individual panel photographs and tables, calling out each control, are provided.

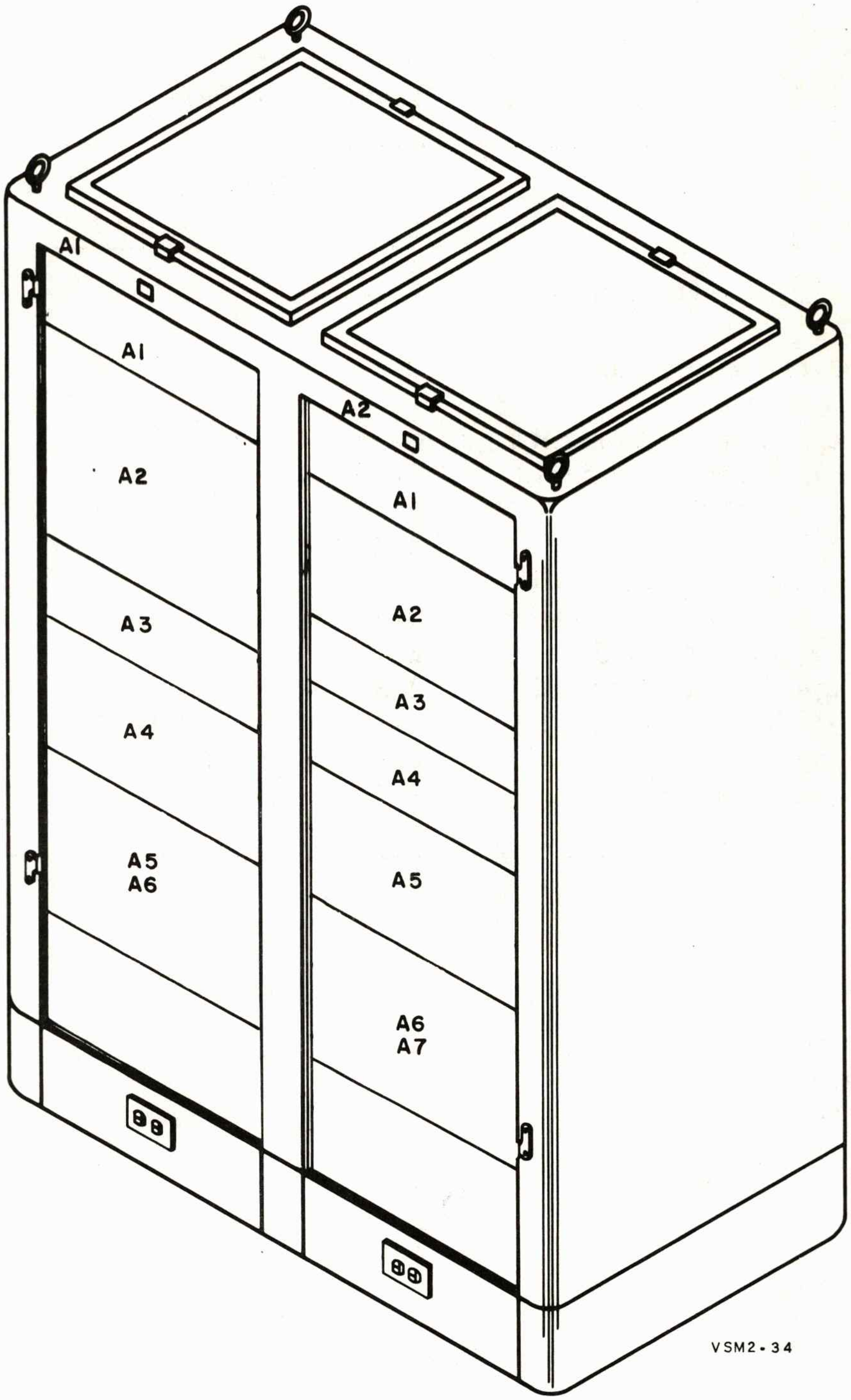
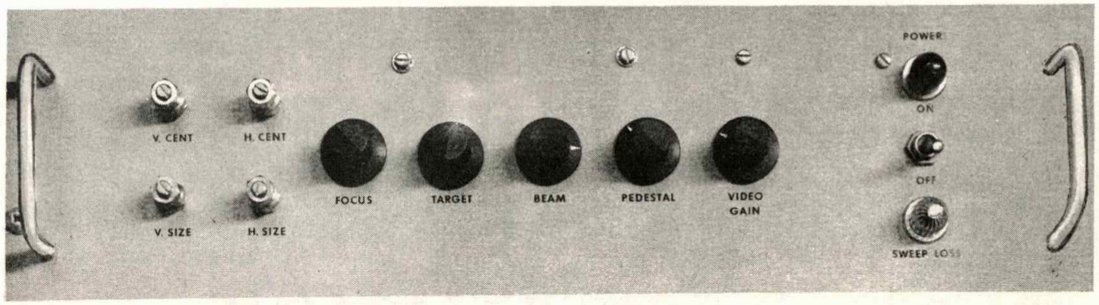


Figure 2-34. Unit 7

Table 2-35. Unit 7 Equipment Cabinet/Location of Panels (See figure 2-34)

Unit No.	Name	For Detail See Table No.	For Detail See Figure No.	Same as
7A1A1	GPL Remote Control Box I	2-36	2-35	
7A1A2	Conrac Television Monitor	2-37	2-36	
7A1A3	Dage Camera Control I	2-38	2-37	
7A1A4	GPL Camera Control I	2-39	2-38	
7A1A5	Camera No I	2-40	2-39	
7A1A6	Projector No II	2-41	2-40	
7A2A1	Remote Control Box II	2-36	2-35	7A1A1
7A2A2	Control Panel Indicator	2-42	2-41	
7A2A3	Waveform Monitor	2-43	2-42	
7A2A4	Dage Camera Control II	2-38	2-37	7A1A3
7A2A5	GPL Camera Control II	2-39	2-38	7A1A4
7A2A6	Projector No 1	2-41	2-39	7A1A6
7A2A7	Camera No II	2-40	2-40	7A1A5

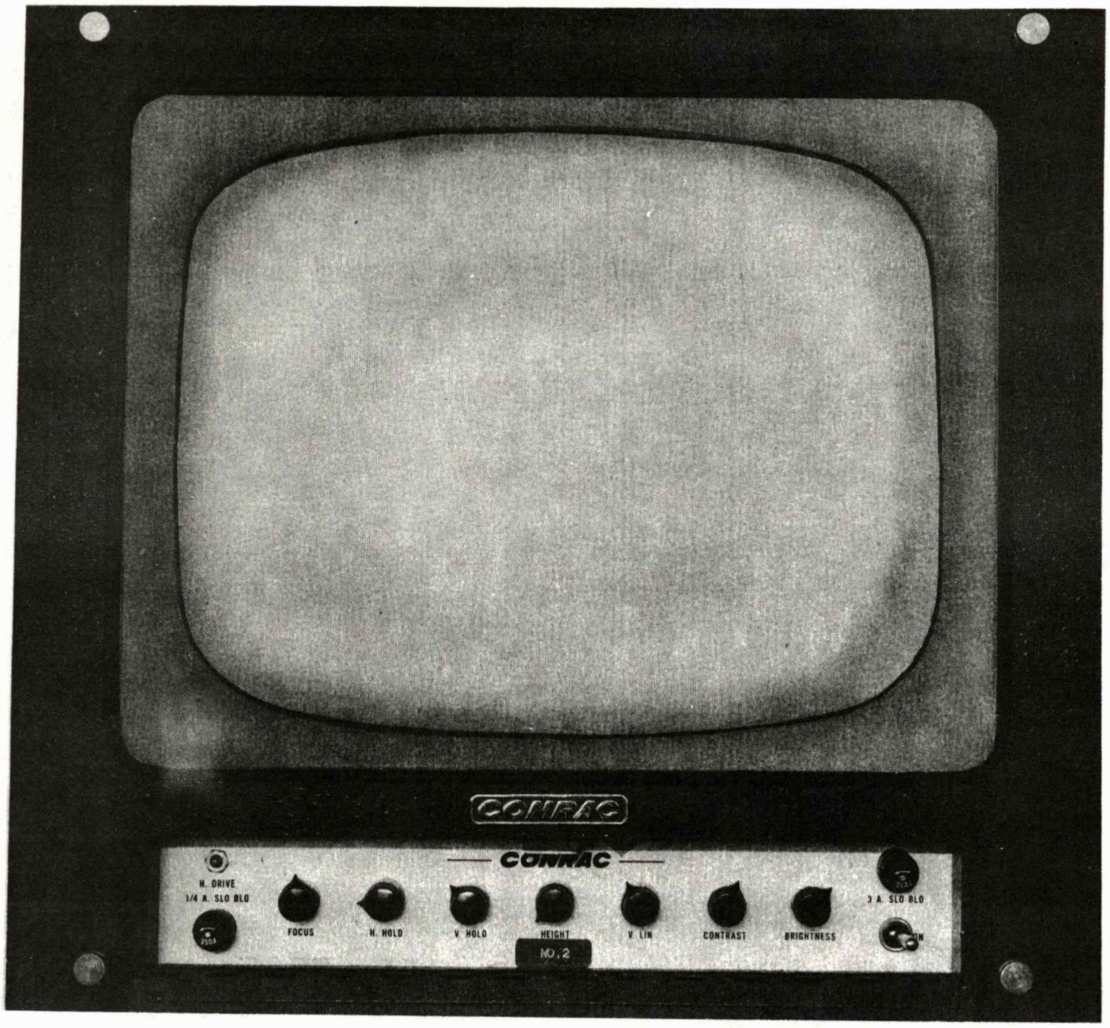


VSM2-35

Figure 2-35. Unit 7A1A1 Remote Control Box I

Table 2-36. Unit 7A1A1 GPL Remote Control Box I/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
V. CENT	Screwdriver, Locking	7A1A1	2-35	Adjusts vertical-display centering on CRT.
H. CENT	Screwdriver, Locking	7A1A1	2-35	Adjusts horizontal-display centering on CRT.
V. SIZE	Screwdriver, Locking	7A1A1	2-35	Adjusts vertical-display size on CRT.
H. SIZE	Screwdriver, Locking	7A1A1	2-35	Adjusts horizontal-display size on CRT No.
FOCUS	Control Pot	7A1A1	2-35	Adjusts display focus on CRT.
TARGET	Control Pot	7A1A1	2-35	Adjusts target voltage.
BEAM	Control Pot	7A1A1	2-35	Adjusts beam current.
PEDESTAL	Control Pot	7A1A1	2-35	Adjusts black level (fine).
VIDEO GAIN	Control Pot	7A1A1	2-35	Adjusts video amplitude.
POWER	Lamp	7A1A1	2-35	Illuminates when "OFF-ON" switch is in the "ON" position.
ON-OFF	Toggle Switch	7A1A1	2-35	Controls.ac power to the unit.
SWEEP LOSS	Neon Lamp	7A1A1	2-35	Indicates sweep failure on CRT.

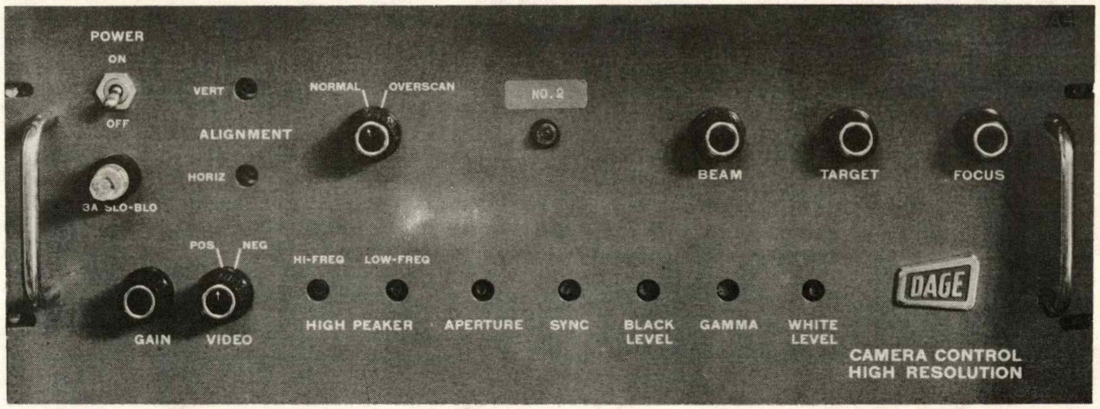


VSM2-36

Figure 2-36. Unit 7A1A2 Conrac Television Monitor

Table 2-37. Unit 7A1A2 Conrac Television Monitor/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
CR	Tube	7A1A2	2-36	Presents monitor display as seen by the vidicon packages.
H. DRIVE	Screwdriver, Nonlocking	7A1A2	2-36	Adjusts horizontal drive pulse width.
1/4 SLOBLO	Fuse	7A1A2	2-36	1/4 amp slow blow fuse used to protect the monitor if an overload occurs.
FOCUS	Control, Pot	7A1A2	2-36	Controls focus of t.v. monitor display.
H. HOLD	Control, Pot	7A1A2	2-36	Holds monitor display in correct horizontal plane.
HEIGHT	Control, Pot	7A1A2	2-36	Adjusts height of display on monitor at top and bottom.
V. LIN	Control, Pot	7A1A2	2-36	Adjusts vertical linearity of display. Used in conjunction with height control.
CONTRAST	Control, Pot	7A1A2	2-36	Controls monitor black to white contrast.
BRIGHTNESS	Control, Pot	7A1A2	2-36	Controls monitor display brightness.
3A SLOBLO	Fuse	7A1A2	2-36	3 amp slow blow fuse protects monitor if an overload occurs.
ON	Toggle Switch	7A1A2	2-36	Controls ac power to the unit.



VSM2-37

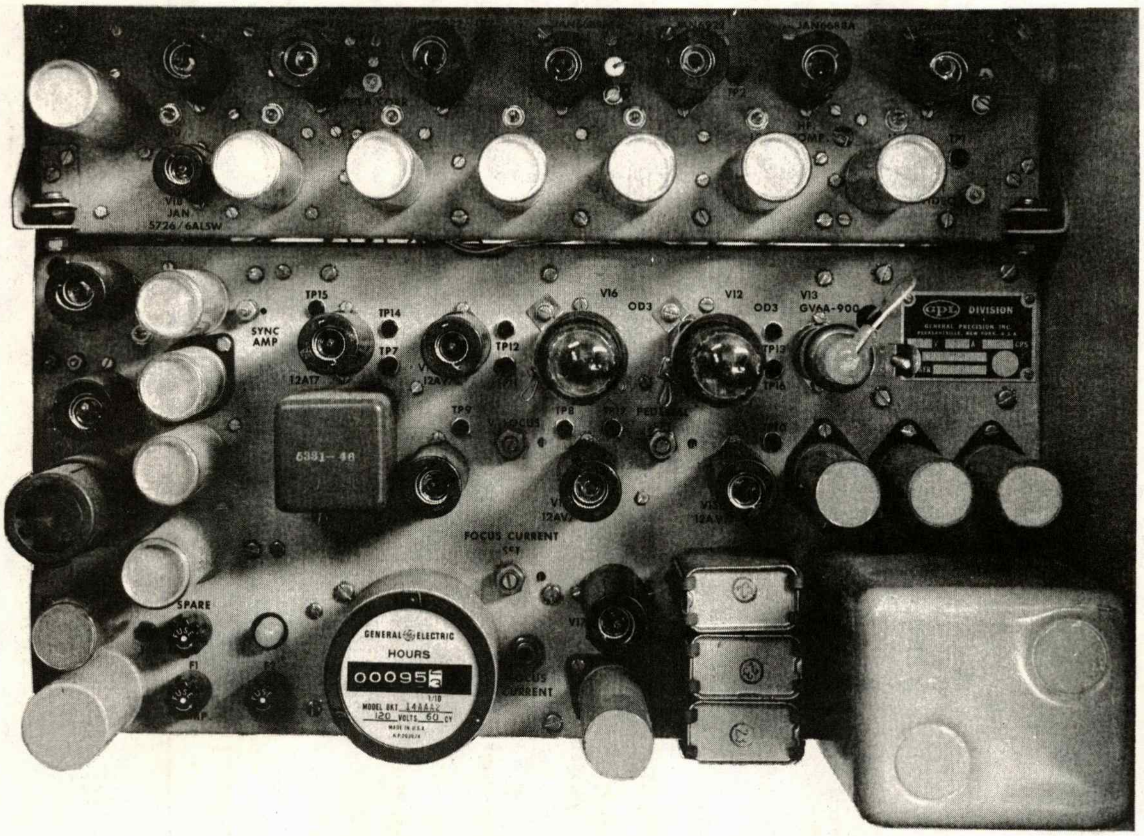
Figure 2-37. Unit 7A1A3 Dage Camera Control I

Table 2-38. Unit 7A1A3 Dage Camera Control I/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
PWR/ON-OFF	Switch	7A1A3	2-37	Controls application of ac power to camera control circuits and camera head.
3A SLO-BLOW	Fuse	7A1A3	2-37	Protects the equipment should an overload occur.
ALIGNMENT/VERT.	Screwdriver Adj.	7A1A3	2-37	Affects positional relationship of the vidicon beam and the tube elements.
ALIGNMENT/HORIZ.	Screwdriver Adj.	7A1A3	2-37	Affects the horizontal position of the beam.
NORMAL-OVERSCAN	Switch	7A1A3	2-37	Not used.
BEAM	Control Potentiometer	7A1A3	2-37	Provides control of the quantity of electrons supplied to the vidicon target via the scanning beam. Rotating this control clockwise increases the beam current.

Table 2-38. Unit 7A1A3 Dage Camera Control I/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TARGET	Control Potentiometer	7A1A3	2-37	Provides adjustment of the voltage applied to the vidicon target. In effect, this controls the vidicon-picture signal "strength". Clockwise rotation increases the dc voltage applied to the target.
FOCUS	Control Potentiometer	7A1A3	2-37	Provides voltage adjustment on the focus grids (G3 and G4) of the vidicon. Its effect is similar to optical focus (when viewed on monitor) and is adjusted for maximum image resolution.
GAIN	Control Potentiometer	7A1A3	2-37	Provides amplitude control for the video signal portion of the camera control.
VIDEO POS/NEG	Control Potentiometer	7A1A3	2-37	Allows presentation of either a positive display or a negative display.
HIGH PEAKER/HI-FREQ.	Screwdriver Adjustment	7A1A3	2-37	Adjusts the amplification of the high frequency video signals.
HIGH PEAKER/LOW-FREQ.	Screwdriver Adjustment	7A1A3	2-37	Provides for adjustment of the amplification of the low frequency video signals.
APERTURE	Screwdriver Adjustment	7A1A3	2-37	Provides for adjustment of the amplification of the highest frequency video signals in order to compensate for the finite spot size of the vidicon scanning beam.
SYNC	Screwdriver Adjustment	7A1A3	2-37	Provides amplitude adjustment of the sync signal appearing with the video output of the processing amplifier.
BLACK LEVEL	Screwdriver Adjustment	7A1A3	2-37	Provides adjustment of the voltage difference between the blackest portions of the video signal and the blanking level in the processing amplifier.
GAMMA	Screwdriver Adjustment	7A1A3	2-37	Provides a compensating adjustment at the camera to enable the video monitor to faithfully reproduce the gray scale or tonal range of the camera scene.
WHITE LEVEL	Screwdriver Adjustment	7A1A3	2-37	Limits the amplitude of the white signal presented to the monitor.

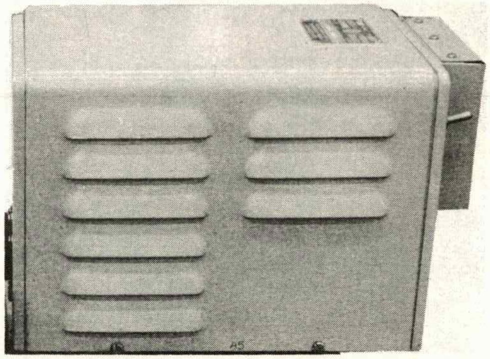


VSM2-38

Figure 2-38. Unit 7A1A4 GPL Camera Control I

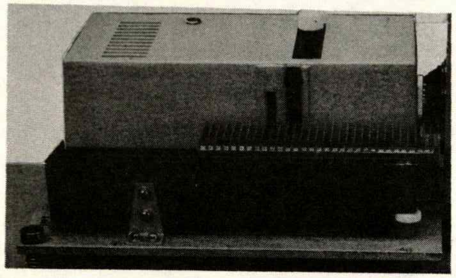
Table 2-39. Unit 7A1A4 GPL Camera Control I/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
"L" Adjustments	Screwdriver Non-locking	7A1A4	2-38	Used to peak up inductance coils.
TP1 through TP12	Test Points	7A1A4	2-38	Used to monitor waveshapes generated by the 7A1A4 GPL Camera Control Unit.
SYNC AMP	Screwdriver Locking	7A1A4	2-38	Adjusts sync amplitude.
V. FOCUS	Screwdriver Locking	7A1A4	2-38	Adjusts vertical focusing.
PEDESTAL SET	Screwdriver	7A1A4	2-38	Adjusts black level (coarse).
FOCUS CURRENT SET	Screwdriver Locking	7A1A4	2-38	Adjusts focus.
SPARE	Fuse	7A1A4	2-38	Spare 3 amp fuse.
F1 3 AMP	Fuse	7A1A4	2-38	Protects GPL Camera Control Unit in case of overload.
F2 3 AMP	Fuse	7A1A4	2-38	Protects GPL Camera Control Unit in case of overload.



VSM2-39

Figure 2-39. Unit 7A1A5 Camera No. 1



VSM2-40

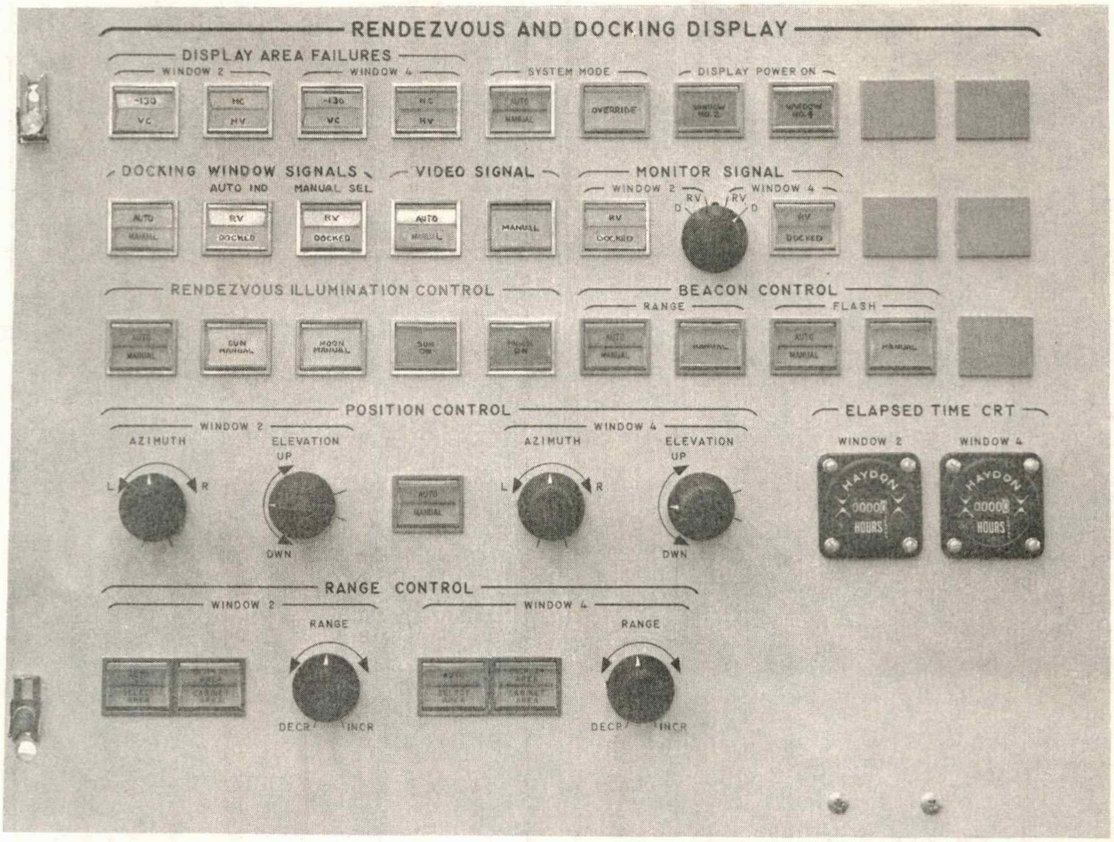
Figure 2-40. Unit 7A1A6 Projector

Table 2-40. Unit 7A1A5 Camera No. 1/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
POS PICTURE/NEG PICTURE	Toggle Switch	7A1A5	2-39	Sets reception of Camera for positive picture or for negative picture.

Table 2-41. Unit 7A1A6 Projector No. 2/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
Switch	Toggle Switch	7A1A6	2-40	Turns Projector power on and off.



VSM2-41

Figure 2-41. Unit 7A2A2 Control Panel Indicator

Table 2-42. Unit 7A2A2 Control Panel Indicator/Control Functions

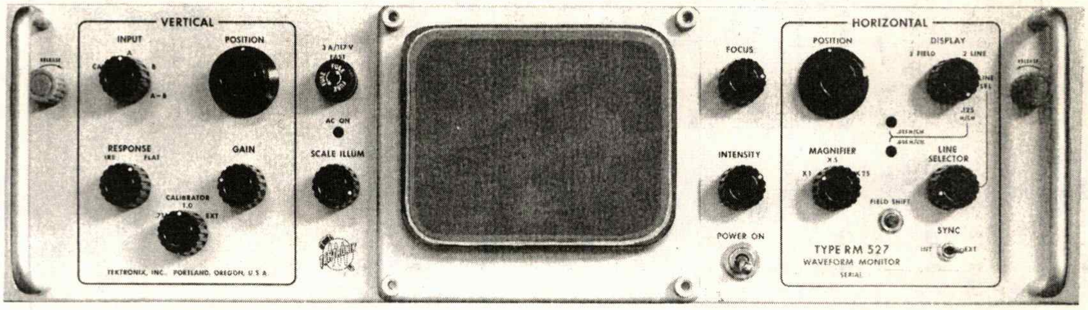
Control or Display	Description	Panel No.	Figure No.	Function
DISPLAY AREA FAILURES				
WINDOW 2, -150 VC	Indicator	7A2A2	2-41	Denotes window number two vertical deflection current failure.
WINDOW 2, HC. HV	Indicator	7A2A2	2-41	Denotes window number two horizontal deflection current and/or horizontal deflection voltage failure.
WINDOW 4, -150 VC	Indicator	7A2A2	2-41	Denotes window number four vertical deflection current failure.
WINDOW 4, HC. HV	Indicator	7A2A2	2-41	Denotes window number four horizontal deflection current and/or horizontal deflection voltage failure.
SYSTEM MODE				
AUTO/MANUAL	Indicator	7A2A2	2-41	Denotes all systems are computer controlled, or one or more systems are manually controlled.
OVERRIDE	Switch	7A2A2	2-41	Places all systems under computer control.
DISPLAY POWER ON				
WINDOW 2	Switch	7A2A2	2-41	Applies power to the window number two display.
WINDOW 4	Switch	7A2A2	2-41	Applies power to the window number four display.
DOCKING WINDOW SIGNALS				
AUTO/MANUAL	Switch	7A2A2	2-41	Selects either computer controlled or manually controlled operation of the docking window signals.
AUTO - RV DOCKED INDICATOR	Indicator	7A2A2	2-41	Indicates that the rendezvous vehicle is in the docked position.
MANUAL - RV DOCKED	Switch	7A2A2	2-41	Allows manual docking of the rendezvous vehicle.
VIDEO SIGNAL				
AUTO/MANUAL	Switch	7A2A2	2-41	Selects either computer controlled or manually controlled operation of the video signal.
MANUAL	Switch	7A2A2	2-41	Allows manual control of the video signal.
MONITORS SIGNAL				
WINDOW 2 RV DOCKED	Indicator	7A2A2	2-41	Indicates that the rendezvous vehicle appears in the docked position in window number two.

Table 2-42. Unit 7A2A2 Control Panel Indicator/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
MONITORS SIGNAL	Rotary Switch	7A2A2	2-41	Controls the signal displayed on the monitor.
WINDOW 4 - RV DOCKED	Indicator	7A2A2	2-41	Indicates that the rendezvous vehicle appears in the docked position in window number four.
RENDEZVOUS ILLUMINATION CONTROL				
AUTO/MANUAL	Switch	7A2A2	2-41	Selects the status of the illumination control, either computer controlled or manually controlled.
SUN MANUAL	Switch	7A2A2	2-41	Controls sun lamp illumination when under manual control.
MOON MANUAL	Switch	7A2A2	2-41	Controls moon lamp illumination when under manual control.
SUN ON	Indicator	7A2A2	2-41	Indicates that sun lamps are illuminated.
MOON ON	Indicator	7A2A2	2-41	Indicates that moon lamps are illuminated.
BEACON CONTROL				
RANGE - AUTO/MANUAL	Switch	7A2A2	2-41	Allows selection of either computer controlled operation or manually controlled operation of the beacon range.
RANGE - MANUAL	Switch	7A2A2	2-41	Controls the output signal of the beacon generator.
FLASH - AUTO/MANUAL	Switch	7A2A2	2-41	Allows selection of either computer controlled operation of the beacon flash.
FLASH - MANUAL	Switch	7A2A2	2-41	Allows manual operation of the beacon flash.
POSITION CONTROL				
WINDOW 2 AZIMUTH	Control	7A2A2	2-41	Controls image position on the window number two CRT left and right of center when under manual control.
WINDOW 2 ELEVATION	Control	7A2A2	2-41	Controls image position on the window number two CRT above and below center when under manual control.
AUTO/MANUAL	Switch	7A2A2	2-41	Selects either computer controlled or manually controlled operations.
WINDOW 4 AZIMUTH	Control	7A2A2	2-41	Controls image position on the window number four CRT, left and right of center when under manual control.

Table 2-42. Unit 7A2A2 Control Panel Indicator/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
WINDOW 4 ELEVATION	Control	7A2A2	2-41	Controls image position on the window number four CRT above and below center when under manual control.
ELAPSED TIME CRT				
WINDOW 2	Counter	7A2A2	2-41	Indicates the total number of operational hours on the window No. two CRT.
WINDOW 4	Counter	7A2A2	2-41	Indicates the total number of operational hours on the window No. four CRT.
RANGE CONTROL				
WINDOW 2 AUTO/SELECT AREA	Switch	7A2A2	2-41	Allows selection of either computer controlled operation or, operation from the display area or cabinet area.
WINDOW 2 DISPLAY AREA/ CABINET AREA	Switch	7A2A2	2-41	Operates under control of the Auto/Select Area switch. When the Auto/Select Area switch is in the "SELECT AREA" position, manual display area control can be operated from the display area station or from the cabinet area station as selected by the DISPLAY AREA/ CABINET AREA switch.
RANGE CONTROL	Potentiometer	7A2A2	2-41	Increases or decreases the apparent range of the rendezvous vehicle.



VSM2-42

Figure 2-42. Unit 7A2A3 Waveform Monitor

Table 2-43. Unit 7A2A3 Waveform Monitor/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
VERTICAL/INPUT	Switch	7A2A3	2-42	Four-position switch selects one of four input signals; CAL. A, B, or A-B differential.
VERTICAL/POSITION	Control	7A2A3	2-42	Positions the trace vertically.
VERTICAL/RESPONSE	Switch	7A2A3	2-42	Two position switch selects the amplifier frequency response; IRE (3.58MC, -20db) or FLAT (DC to 5MC, ±1%).
VERTICAL/GAIN	Control	7A2A3	2-42	Continuously variable control with a minimum range of 2.5 to 1 and a Low-High switch which can reduce the gain 2.5 times in the LOW switch position. The switch is mechanically linked to the Gain control shaft so that its operation is nearly automatic. When the switch is in the Low position and the Gain control is rotated fully clockwise, slight further rotation will actuate the switch. The switch is now in the High position. To return the switch to the Low position, rotate the Gain control fully counterclockwise and actuate the switch. Neon indicator lights above the Gain control indicate the selected switch setting.
VERTICAL/CALIBRATOR	Switch	7A2A3	2-42	Three position switch selects either a 0.714 volt or 1.0 volt peak to peak (±1%) internal calibrator signal, or an external calibrator signal.
SCALE ILLUM	Control	7A2A3	2-42	Turns the instrument power on and off and controls graticule illumination.
FOCUS	Control	7A2A3	2-42	Control adjusts the beam for maximum trace sharpness.
HORIZONTAL/POSITION	Control	7A2A3	2-42	A ten turn control to position the trace horizontally.
HORIZONTAL/DISPLAY	Switch	7A2A3	2-42	Six position switch to select RGB field or line, 2 fields or lines of video signal, vertical interval test signal, or 0.125 H/CM sweep rate. The 2 Field or 2 Line positions of the Display switch are used for general waveform monitoring. When the Display switch is set to the 2 Field position, the sweep operates at the frame rate, displaying approximately 1-1/2 fields. The Field Shift button is used in conjunction with this switch position to switch between odd and even fields. When the Display switch is set to the 2 Line position, the sweep operates at 1/2 television line rate, displaying approximately 1-1/2 lines.

Table 2-43. Unit 7A2A3 Waveform Monitor/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
HORIZONTAL/DISPLAY (Cont)				In the VIT position, the sweep operates at the field rate and is triggered by the first serrated pulse in the vertical sync. pulse train. With Magnifier switch set to X5 position, and entire three or four line test signal can be displayed in detail on the screen. When the Magnifier switch is set to the X25 position, any one line will fill the screen. When the Display switch is set to the .125 H/CM position, horizontal sync timing is measured in terms of H (the time between horizontal sync pulses or the time from the start of one horizontal line to the start of the next line). When the Magnifier switch is placed to the X1 position, one complete horizontal line is displayed in a sweep length of 8 centimeters. When the Magnifier is placed in the X5 or X25 position, neon lights indicate the time-base rate selected in terms of H for .025 H/CM or .005 H/CM pulse measurements. In the RGB Line and Field positions of the Display switch, the sweep length is reduced to three centimeters and a 20-cycle staircase Horiz. Input signal of correct amplitude positions the attenuated sweep-trace length to the left during the red line of field display time, to the center during the screen line or field display time, and the the right during the blue line or field display time. The instrument does not initiate the camera switching signal in the RGB Field position the sweep operates at the field rate. Not the frame rate, in the RGB line position, the sweep operates at the line rate, not one-half of the line rate as in the two-line dispaly.
INTENSITY	Control	7A2A3	2-42	Control to vary the trace brightness.
MAGNIFIER	Switch	7A2A3	2-42	Three-position switch to select sweep-magnification ratios of X1, X5, or X25 for all except RBG positions of the Display switch.
LINE SELECTOR	Switch	7A2A3	2-42	Permits detailed observation of any on TV line in a frame.
FIELD SHIFT	Switch	7A2A3	2-42	Pushbutton switch for selecting odd and even fields. Use this switch only when the Display switch is set to the 2 Field position.
SYNC	Switch	7A2A3	2-42	Two-position switch to select either internal or external sync.

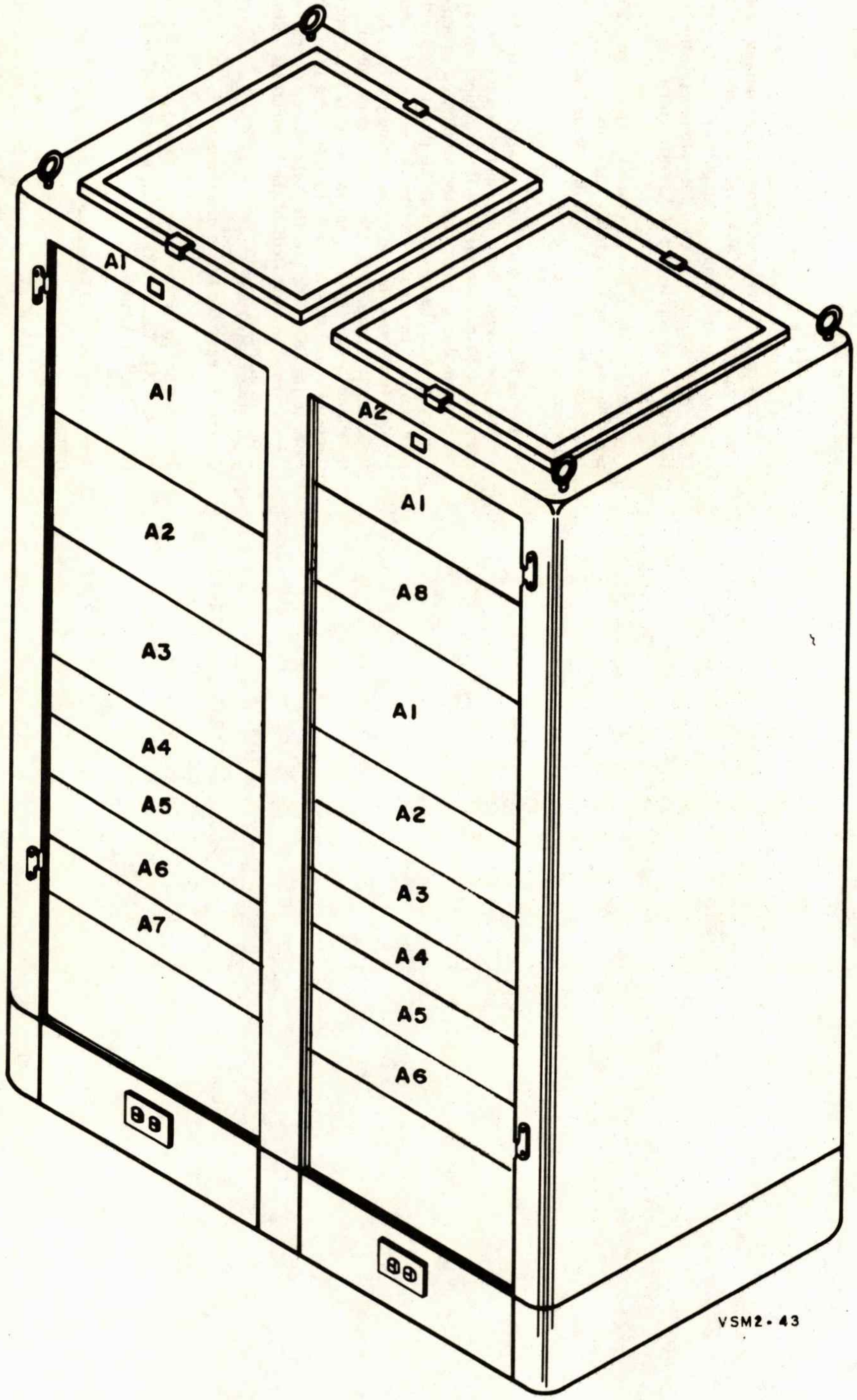
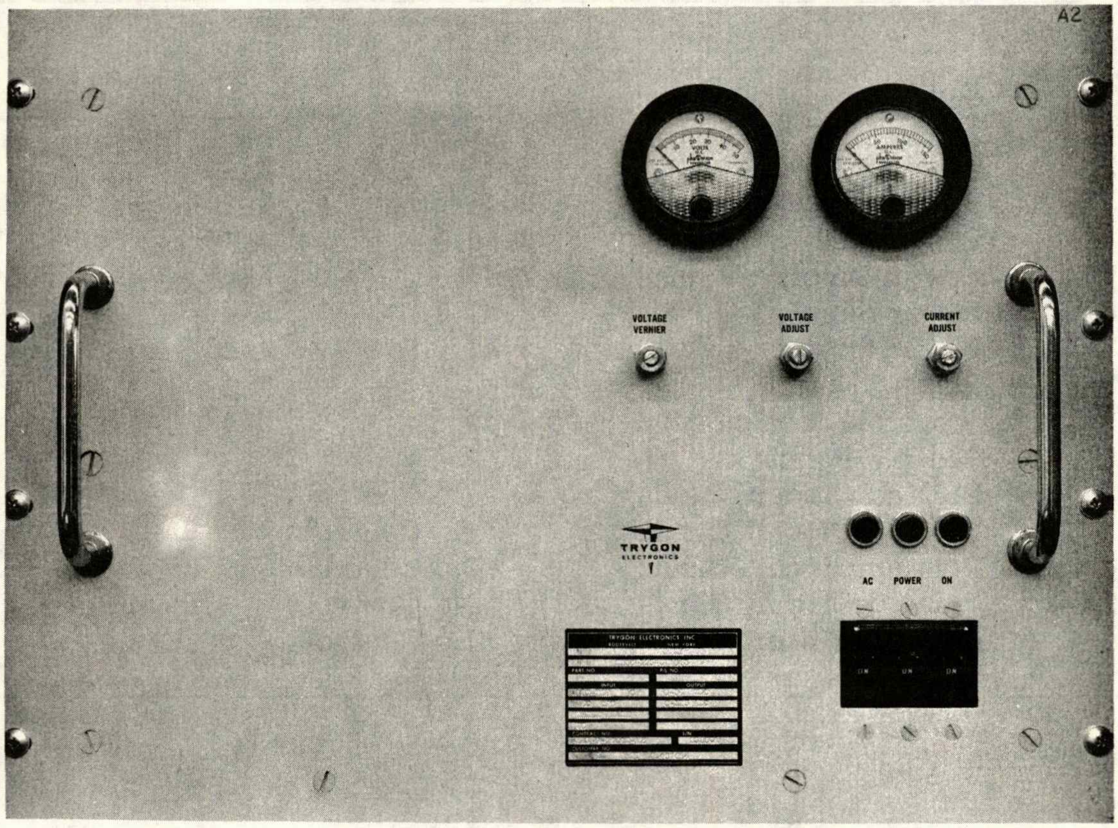


Figure 2-43. Unit 6

Table 2-44. Unit 6 Equipment Cabinet/Location of Panels (See figure 2-43)

Unit No.	Name	For Detail See Table No.	For Detail See Figure No.	Same as
6A1A2	Power Supply	2-45	2-44	
6A1A3	Power Supply	2-45	2-44	6A1A2
6A1A4	Power Supply	2-46	2-45	
6A1A5	Power Supply	2-46	2-45	6A1A4
6A1A6	Power Supply	2-47	2-46	
6A1A7	Power Supply	2-47	2-46	6A1A6
6A2A8	Relay Chassis	2-48	2-47	
6A2A1	Servo Maintenance Control Panel	2-49	2-48	
6A2A2	Printed Circuit Cards	No Controls		
6A2A3	Printed Circuit Cards	No Controls		
6A2A4	Printed Circuit Cards	No Controls		
6A2A5	Printed Circuit Cards	No Controls		
6A2A6	Printed Circuit Cards	No Controls		

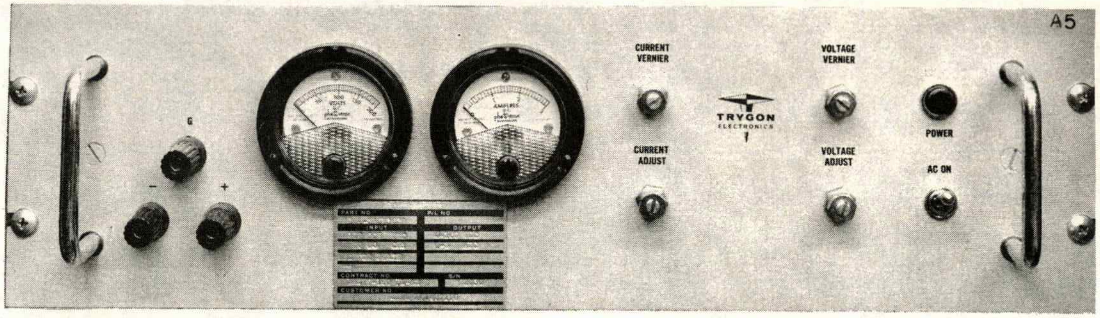


VSM2-44

Figure 2-44. Unit 6A1A2 Power Supply (437684)

Table 2-45. Unit 6A1A2 Power Supply (437684)/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
Voltmeter	Voltmeter	6A1A2	2-44	Indicates dc output voltage. Scale 0 to 50 vdc.
Ammeter	Ammeter	6A1A2	2-44	Indicates dc output current. Scale 0 to 150 amperes.
VOLTAGE VERNIER	Screwdriver, Locking	6A1A2	2-44	Fine voltage control adjustment.
VOLTAGE ADJUST	Screwdriver, Locking	6A1A2	2-44	Coarse voltage control adjustment.
CURRENT ADJUST	Screwdriver, Locking	6A1A2	2-44	Current control adjustment.
Indicator Lamps	Three Lamps	6A1A2	2-44	One lamp for each phase of ac input. All lamps illuminate when three phase ac is "ON". If one leg of three phase ac drops the associated lamp will go off.
AC POWER ON	Three Switches, Mechanically Interconnected	6A1A2	2-44	Applies 3 phase ac power to the power supply. Switches are mechanically interlocked so that all three switches must be turned on at once. Up position is "ON".

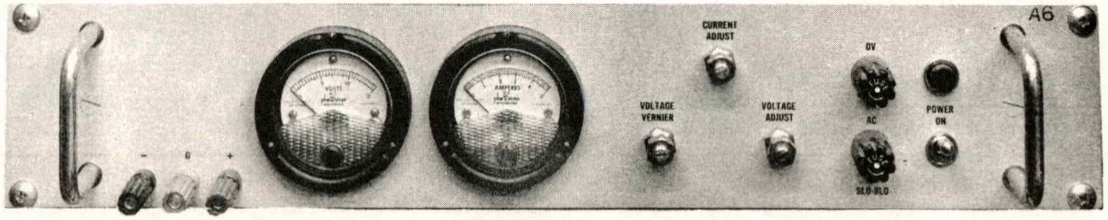


VSM2-45

Figure 2-45. Unit 6A1A4 Power Supply (437178)

Table 2-46. Unit 6A1A4 Power Supply (437178)/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
G	Test Jack	6A1A4	2-45	Test jack at ground potential used as ground reference when monitoring positive or negative voltages at test jacks + and -.
-	Test Jack	6A1A4	2-45	Used to monitor negative voltage output.
+	Test Jack	6A1A4	2-45	Used to monitor positive voltage output.
DC	Voltmeter	6A1A4	2-45	Indicates dc voltage level at power supply output. Scale 0 to 200 volts.
Ammeter	Ammeter	6A1A4	2-45	Indicates ampere level at power supply output. Scale 0 to 3 amps.
CURRENT VERNIER	Screwdriver, Locking	6A1A4	2-45	Fine control of output current.
CURRENT ADJUST	Screwdriver, Locking	6A1A4	2-45	Coarse control of output current.
VOLTAGE VERNIER	Screwdriver, Locking	6A1A4	2-45	Fine control of output voltage.
VOLTAGE ADJUST	Screwdriver, Locking	6A1A4	2-45	Coarse control of output voltage.
Lamp	Lamp	6A1A4	2-45	Indicates when "ON-OFF" switch is in the "ON" position.
ON-OFF	Toggle Switch	6A1A4	2-45	Controls ac power to the power supply.

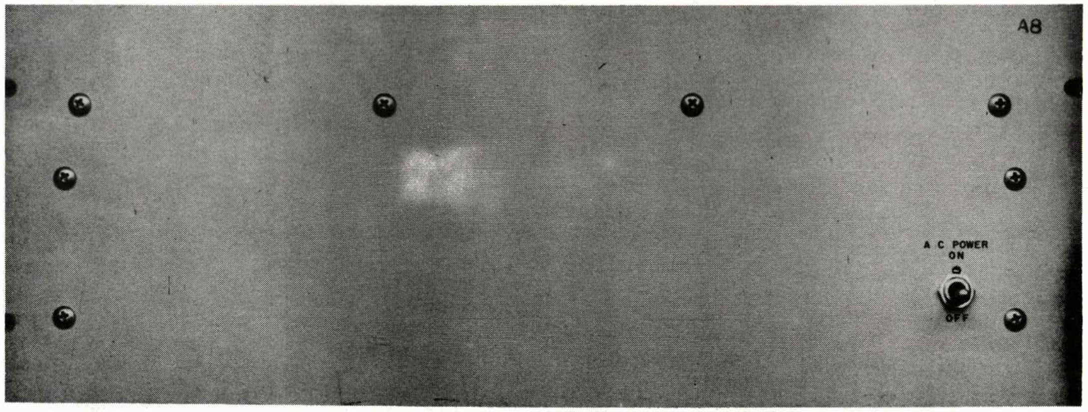


VSM2-46

Figure 2-46. Unit 6A1A6 Power Supply (437681)

Table 2-47. Unit 6A1A6 Power Supply (437681)/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
-	Test Jack	6A1A6	2-46	Test jack used for checking - dc volt output between test jack - and test jack G.
G	Test Jack	6A1A6	2-46	Test jack at ground potential used for ground reference with Test jack - and +.
+	Test Jack	6A1A6	2-46	Used for checking + dc volt output between test jack - and test jack +.
Voltmeter	Voltmeter	6A1A6	2-46	Indicates dc voltage level at power supply output. Scale 0 to 15 volts.
Ammeter	Ammeter	6A1A6	2-46	Indicates dc ampere level at power supply output. Scale 0 to 5 amps.
VOLTAGE VERNIER	Screwdriver, Locking	6A1A6	2-46	Fine adjustment for dc output voltage.
CURRENT ADJUST	Screwdriver, Locking	6A1A6	2-46	Adjustment for dc output current.
VOLTAGE ADJUST	Screwdriver, Locking	6A1A6	2-46	Coarse adjustment for dc output voltage.
Fuse	Fuse	6A1A6	2-46	Protects output.
Fuse	Fuse	6A1A6	2-46	Protects input.
Lamp	Lamp	6A1A6	2-46	Indicates when "OFF-ON" switch is in the "OFF" position.
POWER ON	Toggle Switch	6A1A6	2-46	Applies 115 vac power to power supply.

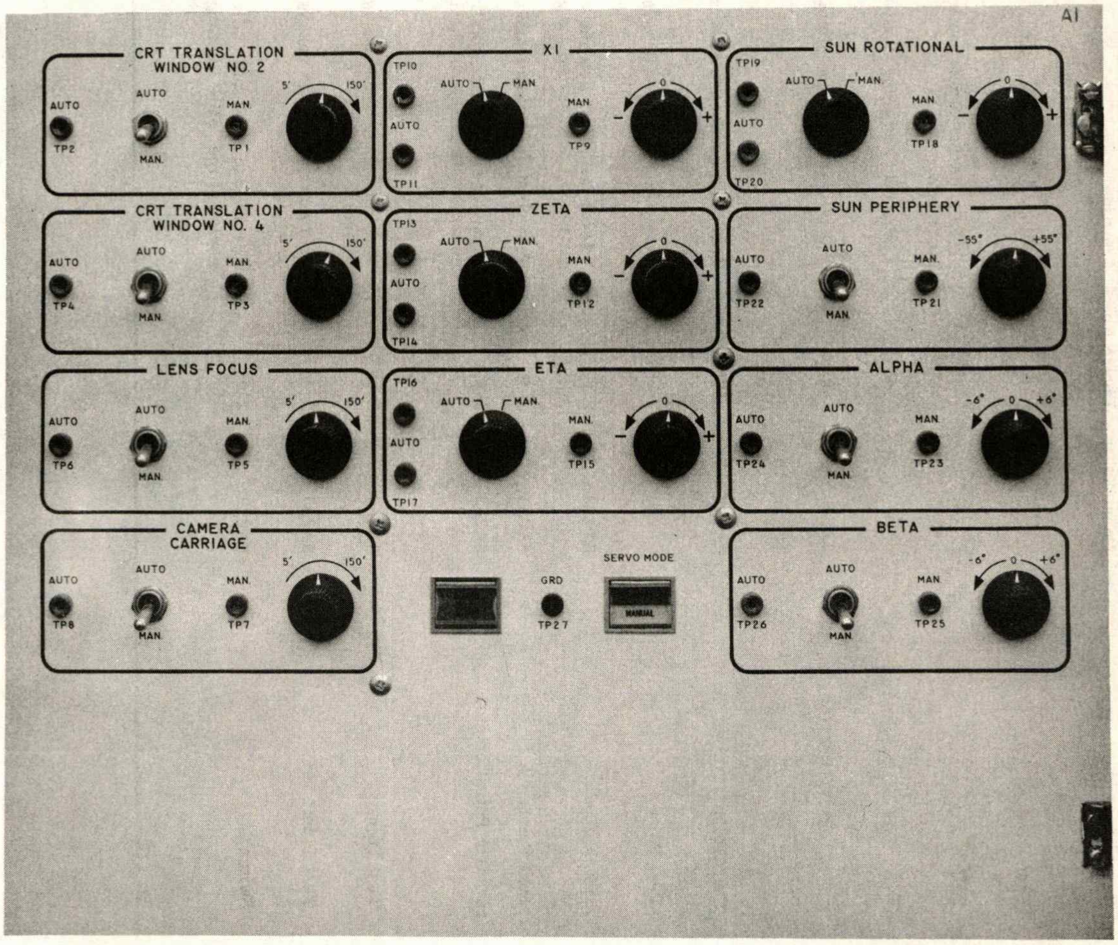


VSM2-47

Figure 2-47. Unit 6A2A8 Relay Chassis

Table 2-48. Unit 6A2A8 Relay Chassis/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
AC POWER ON OFF	Toggle Switch	6A2A8	2-47	Applies ac power to relay chassis.



VSM2-48

Figure 2-48. Unit 6A2A1 Servo Maintenance Control Panel

Table 2-49. Unit 6A2A1 Servo Maintenance Control Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
CRT TRANSLATION WINDOW NO. 2				
AUTO/TP2	Test Point	6A2A1	2-48	Test point used when subsystem is in automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects manual or automatic control of CRT translation window.
MAN/TP1	Test Point	6A2A1	2-48	Test point used when subsystem is under manual control.
5' -150'	Control Potentiometer	6A2A1	2-48	Manually controls the simulated movement of the CRT from 5 to 150 feet.
XI				
TP10/AUTO	Test Point	6A2A1	2-48	Test point used when subsystem is in automatic control.
AUTO/TP11	Test Point	6A2A1	2-48	Test point used when subsystem is in automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects manual or automatic control of XI (rotational motion of the intermediate gimbal of the LEM).
MAN/TP9	Test Point	6A2A1	2-48	Test point used when subsystem is in manual control.
- to +	Control Potentiometer	6A2A1	2-48	Manually controls the rotational movement of the intermediate gimbal of the LEM model gimbal system.
SUN ROTATIONAL				
TP19/AUTO	Test Point	6A2A1	2-48	Test point used when subsystem is under automatic control.
AUTO/TP20	Test Point	6A2A1	2-48	Test point used when subsystem is under automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects manual or automatic control of the rotational motion of the "SUN" lighting system gimbal.

Table 2-49. Unit 6A2A1 Servo Maintenance Control Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
- to +	Control Potentiometer	6A2A1	2-48	Manually controls rotational motion of the "SUN" lighting system gimbal.
CRT TRANSLATION WINDOW NO. 4				
AUTO/TP6	Test Point	6A2A1	2-48	Test point used when subsystem is under automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects automatic or manual control of CRT translation window.
5' -150'	Control Potentiometer	6A2A1	2-48	Manually controls the simulated movement of the CRT from 5 to 150 feet.
ZETA				
TP13/AUTO	Test Point	6A2A1	2-48	Test point used when subsystem is under automatic control.
AUTO/TP14	Test Point	6A2A1	2-48	Test point used when subsystem is under automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects automatic or manual control of the rotational motion of the outer gimbal of the LEM model gimbal system.
- to +	Control Potentiometer	6A2A1	2-48	Manually controls the rotational motion of the outer gimbal of the LEM model gimbal system.
SUN PERIPHERY				
AUTO/TP22	Test Point	6A2A1	2-48	Test point used when subsystem is under automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects automatic or manual control of the translational motion of the "SUN" carriage around the periphery of the "SUN" gimbal.
MAN/TP21	Test Point	6A2A1	2-48	Test point used when subsystem is under manual control.
-55° to 55°	Control	6A2A1	2-48	Manually controls the translational motion of the "SUN" carriage around the periphery of the "SUN" gimbal a simulated -55 to +55 degree arc.
LENS FOCUS				
AUTO/TP6	Test Point	6A2A1	2-48	Test point used when subsystem is under automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects automatic or manual control of the lens focus.

Table 2-49. Unit 6A2A1 Servo Maintenance Control Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
MAN/TP5	Test Point	6A2A1	2-48	Test point used when subsystem is under manual control.
5' to 150'	Control	6A2A1	2-48	Manually controls the lens focus for simulated movement from 5 to 150 feet.
ETA				
TP16/AUTO	Test Point	6A2A1	2-48	Test point used when ETA subsystem is under automatic control.
AUTO/TP17	Test Point	6A2A1	2-48	Test point used when ETA subsystem is under automatic control.
AUTO/MANUAL	Switch	6A2A1	2-48	Selects automatic or manual control of rotational motion of the inner gimbal of the LEM model gimbal system.
MAN/TP15	Test Point	6A2A1	2-48	Test point used when subsystem is under manual control.
- to +	Control	6A2A1	2-48	Manually controls the rotational motion of the inner gimbal of the LEM model gimbal system.
ALPHA				
AUTO/TP24	Test Point	6A2A1	2-48	Test point used when subsystem "ALPHA" is under automatic control.
AUTO/MANUAL	Switch	6A2A1	2-48	Selects automatic or manual control of the rotational motion of the camera in the plane perpendicular to the plane of the carriage.
MAN/TP23	Test Point	6A2A1	2-48	Test point used when subsystem "ALPHA" is under manual control.
-6° to 6°	Control Potentiometer	6A2A1	2-48	Manually controls the rotational motion of the camera in a plane perpendicular to the plane of the carriage from a simulated -6 to 6 degree arc.
CAMERA CARRIAGE				
AUTO/TP8	Test Point	6A2A1	2-48	Test point used when "camera carriage" subsystem is under automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects manual or automatic control of the "camera carriage" subassembly.
MAN/TP7	Test Point	6A2A1	2-48	Test point used when subassembly is under manual control.

Table 2-49. Unit 6A2A1 Servo Maintenance Control Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
5' to 150'	Control Potentiometer	6A2A1	2-48	Manually controls the "camera carriage" simulated distance from 5 to 150 feet.
POWER DELAY ACTIVE				
GRD/TP27	Test Point	6A2A1	2-48	Test point at ground potential used as ground reference for all test points on the panel.
SERVO MODE				
AUTO/MANUAL	Indicator Lamp	6A2A1	2-48	Any subsystem under manual control will cause the "servo mode" to read "MANUAL". When all subsystems are under automatic control the indicator will read "AUTO".
BETA				
AUTO/TP26	Test Point	6A2A1	2-48	Test point used when "BETA" subsystem is under automatic control.
AUTO/MAN	Switch	6A2A1	2-48	Selects manual or automatic control of the rotational motion of the camera in the plane of the carriage.
MAN/TP25	Test Point	6A2A1	2-48	Test point used when subsystem is under manual control.
-6^{o} to $+6^{o}$	Control Potentiometer	6A2A1	2-48	Manually controls the rotational motion of the camera in the plane of the carriage; a simulated -6 to 6 degree arc.

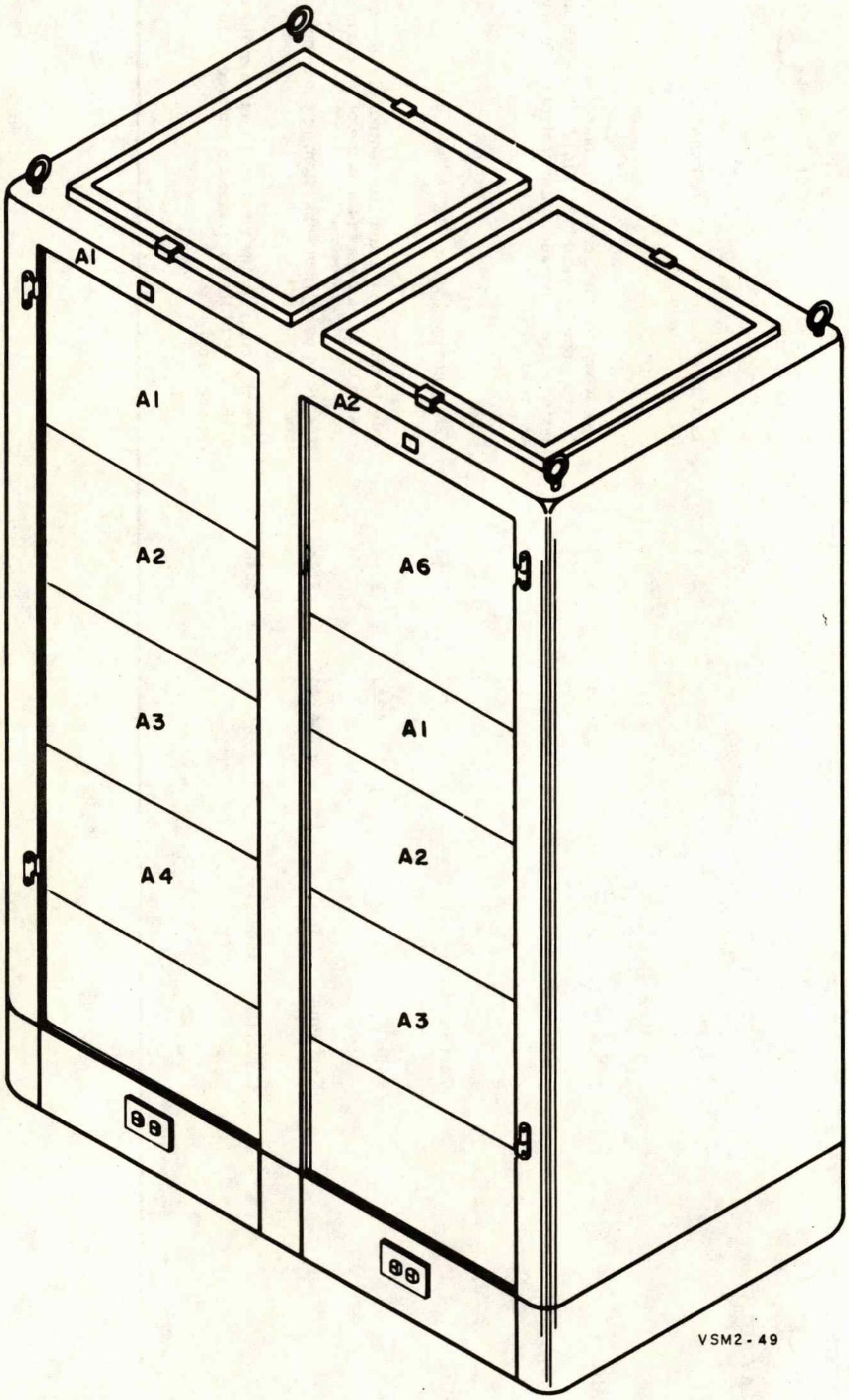
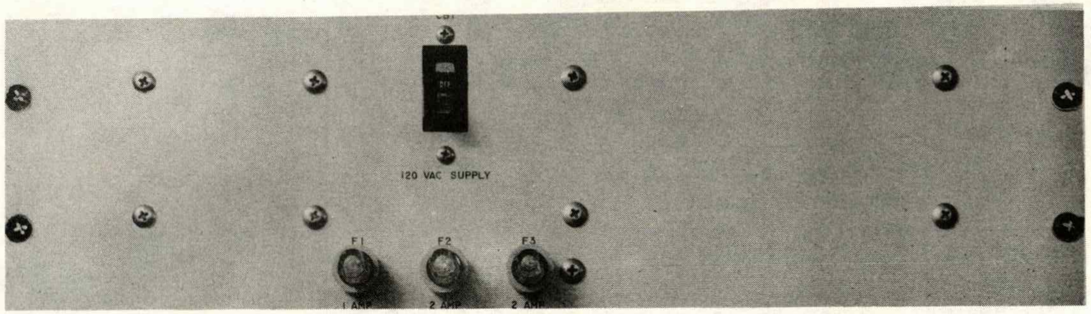


Figure 2-49. Unit 8

Table 2-50. Unit 8 Equipment Cabinet/Location of Panels (See figure 2-49)

Unit No.	Name	For Detail See Table No.	Figure No.	Same as
8A1A1	DC Distribution Panel	No Controls		
8A1A2	Relay Assembly	No Controls		
8A1A3	AC Distribution Panel	2-51	2-50	
8A1A4	Power Supply	2-52	2-51	
8A1A5	Power Supply	2-53	2-52	
8A1A6	Power Supply	2-53	2-52	8A1A5
8A2A1	Power Supply	2-52	2-51	8A1A4
8A2A2	Power Supply	2-52	2-51	8A1A4
8A2A3	Power Supply	2-53	2-52	8A1A5
8A2A4	GPL Power Supply	2-54	2-53	
8A2A5	GPL Power Supply	2-54	2-51	8A2A4
8A2A6	Synchronizing Generator Controls	2-55	2-54	
8A2A7	Power Supply	2-53	2-52	8A1A5
8A2A8	Power Supply	2-53	2-52	8A1A5
8A2A9	Voltage Regulator	2-56	2-55	

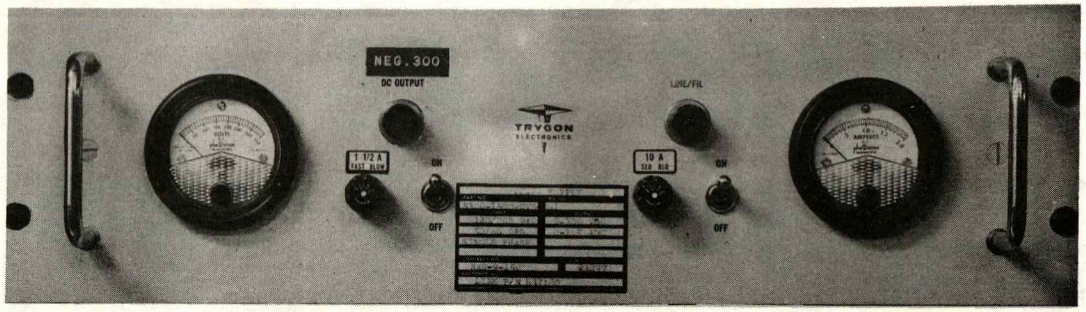


VSM2-50

Figure 2-50. Unit 8A1A3 AC Distribution Panel

Table 2-51. Unit 8A1A3 AC Distribution/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
CB1 120VAC Supply	Switch	8A1A3	2-50	Ac power switch.
F1 1 Amp	Fuse	8A1A3	2-50	1 amp fuse for ac line protection.
F2 2 Amp	Fuse	8A1A3	2-50	2 amp fuse.
F3 2 Amp	Fuse	8A1A3	2-50	2 amp fuse.

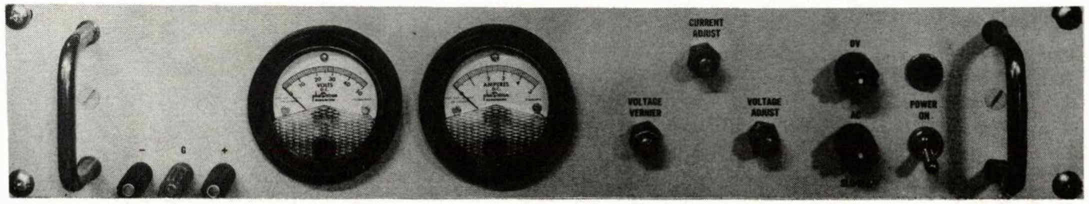


VSM2-51

Figure 2-51. Unit 8A1A4 Power Supply

Table 2-52. Unit 8A1A4 Power Supply (437180)/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
DC	Meter	8A1A4	2-51	Indicates dc output level scale 0 to 350 volts.
1-1/2 A FAST BLOW	Fuse	8A1A4	2-51	Protects dc output circuits in case of overload.
DC OUTPUT	Lamp	8A1A4	2-51	Indicates the dc output switch is in the "ON" position.
ON-OFF	Toggle Switch	8A1A4	2-51	Turns on the dc output circuits.
10A SLO BLO	Fuse	8A1A4	2-51	Slow Blow fuse protects the power supply in case of overload.
LINE/FIL	Lamp	8A1A4	2-51	Indicates the ac power is on, the power supply filaments are energized and the power supply is in the standby condition.
ON-OFF	Toggle Switch	8A1A4	2-51	Controls ac power to the power supply.
Ammeter	Ammeter	8A1A4	2-51	Indicates ac current level at the power supply output. Scale 0 to 2.

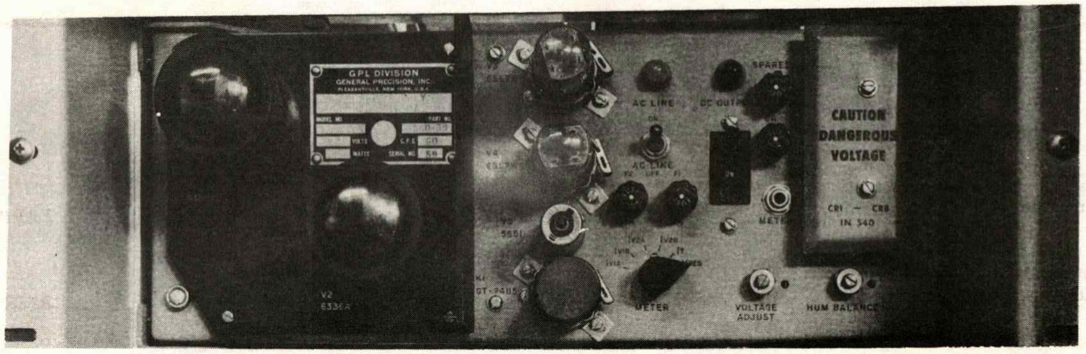


VSM2-52

Figure 2-52. Unit 8A1A5 Power Supply

Table 2-53. Unit 8A1A5 Power Supply (437714)/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
+	Test Jack	8A1A5	2-52	Used for monitoring positive dc output between + test jack and G test jack.
G	Test Jack	8A1A5	2-52	Ground reference for checking + test jack and - test jack voltage outputs.
-	Test Jack	8A1A5	2-52	Used for monitoring negative dc output between - test jack and G test jack.
DC	Voltmeter	8A1A5	2-52	Indicates dc voltage level at power supply output. Scale 0 to 50 vdc.
Ammeter	Ammeter	8A1A5	2-52	Indicates dc ampere level at power supply output. Scale 0 to 5 amps.
VOLTAGE VERNIER	Screwdriver, Locking	8A1A5	2-52	Fine control adjustment for dc output voltage.
CURRENT ADJUST	Screwdriver, Locking	8A1A5	2-52	Control adjustment for output current.
VOLTAGE ADJUST	Screwdriver, Locking	8A1A5	2-52	Coarse control adjustment for dc output voltage.
0V 5A	Fuse	8A1A5	2-52	5 amp fast blow fuse protects the output circuits in case of overload.
AC 10A SLO BLO	Fuse	8A1A5	2-52	10 amp slow blow fuse protects the power supply in case of overload.
Indicator Lamp	Lamp	8A1A5	2-52	Lamp lights when ac power is applied to the power supply.
POWER ON	Toggle Switch	8A1A5	2-52	Controls ac power to the power supply.



VSM2-53

Figure 2-53. Unit 8A2A4 GPL Power Supply

Table 2-54. Unit 8A2A4 GPL Power Supply/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
Lamp	Lamp	8A2A4	2-53	Indicator lamp indicates that ac power is on.
AC LINE ON AC LINE OFF	Toggle Switch	8A2A4	2-53	Applies a-c power to the power supply.
Lamp	Lamp	8A2A4	2-53	Indicates d-c OUTPUT switch is on.
DC OUTPUT	Switch	8A2A4	2-53	Turns d-c output on.
Meter Switch	Switch	8A2A4	2-53	Connects outputs to meter jack.
Meter Jack	Test Jack	8A2A4	2-53	Jack receptacle for monitoring power supply voltages.
VOLTAGE ADJUST	Screwdriver, Locking	8A2A4	2-53	Adjust output d-c voltage.
HUM BALANCE	Potentiometer	8A2A4	2-53	Adjusts frequency to remove amplitude difference.

VSM2-54

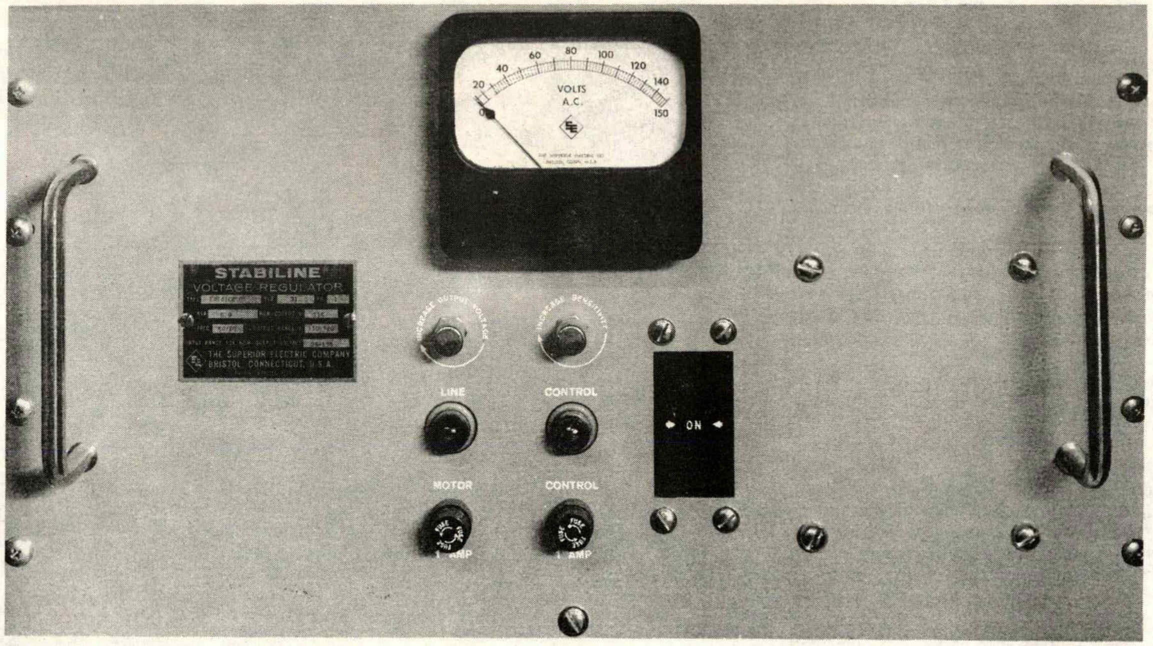
Figure 2-54. Unit 8A2A6 Synchronizing Generator

Table 2-55. Unit 8A2A6 Synchronizing Generator/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
H. BLANK WIDTH	Screwdriver Adj.	8A2A6	2-54	Provides width (time duration) adjustment of the horizontal blanking pulses at the synchronizing generator output.
SYNC	Test Point	8A2A6	2-54	Test point.
V. BLANK WIDTH	Screwdriver Adj.	8A2A6	2-54	Provides width (time duration) adjustment of the vertical blanking pulses at the synchronizing generator output.
BLANK	Test Point	8A2A6	2-54	Test point.
MASTER OSC. ADJ/H. DRIVE	Screwdriver Adj.	8A2A6	2-54	Provides width (time duration) adjustment of the horizontal drive pulses at the synchronizing generator output.
MASTER OSC. ADJ/V. DRIVE	Screwdriver Adj.	8A2A6	2-54	Provides width (time duration) adjustment of the verical drive pulses at the synchronizing generator output.
H DRIVE	Test Point	8A2A6	2-54	Test point.
V DRIVE	Test Point	8A2A6	2-54	Test point.

Table 2-55. Unit 8A2A6 Synchronizing Generator/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
AFC-OFF	Switch Position	8A2A6	2-54	When switch is in this position, the master oscillator is free-running, without any frequency controlling circuitry connected to it. This position is used primarily for set up and maintenance purposes.
AFC-SLOW	Switch Position	8A2A6	2-54	When the switch is in this position, the master oscillator output (when properly adjusted) is locked to the 60 cycle power line. Automatic circuit operation in this position meets maximum allowable rate of change of frequency over the limits ±1%.
AFC-FAST	Switch Position	8A2A6	2-54	Same as AFC-Slow except AFC pull-in action is speeded up to permit holding to a higher rate of change in line frequency.
EXT	Switch Position	8A2A6	2-54	In this position circuitry is connected for optional external control of the master oscillator frequency from either of two sources as selected by the Color/Rem. Gen. Lock toggle switch.
XTAL	Switch Position	8A2A6	2-54	When the switch is in this position, the master oscillator is crystal controlled. This mode of operation is provided for occasions when locking to line is not desirable, such as emergency power sources, etc.
COLOR/REM GEN LOCK	Switch	8A2A6	2-54	When switch is in Color position (and S2 above is in Ext); control of the master oscillator frequency is committed to an external signal fed into the connector labeled Color on the rear of the unit. When this switch is in the Rem Gen Lock position (and S2 about is in Ext position); master oscillator frequency is controlled by an external AFC voltage and vertical pulses are automatically phased with a remote generator.
TEST FOR LOCK	Pushbutton Control	8A2A6	2-54	Provides a means for testing sync generator lock-in to the external synchronizing generator.
SELECTOR SWITCH	Switch	8A2A6	2-54	This switch must be in the position corresponding to the position of the plug-in unit. The plug-in unit may be installed in either side for operating convenience but when changing it from one side to another the "Selector" must also be switched.
1 - 2	Indicators	8A2A6	2-54	Indicates the position of the "Selector" switch.
PHASE KNOB	Control	8A2A6	2-54	Provides adjustment for the phase of the line frequency reference signal in the AFC circuit to enable the generator to be phased with external devices such as film projectors operating on the power line.



VSM2-55

Figure 2-55. Unit 8A2A9 Voltage Regulator

Table 2-56. Unit 8A2A9 Voltage Regulator/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
VOLTS AC	Meter	8A2A9	2-55	Registers regulated a-c voltage of the regulator. (See at 120 vac)
INCREASE OUTPUT VOLTAGE	Control Potentiometer	8A2A9	2-55	Allows regulation of the output voltage.
INCREASE SENSITIVITY	Control Potentiometer	8A2A9	2-55	Controls sensitivity to voltage adjustments.
LINE	Indicator Lamp	8A2A9	2-55	Indicates power is available.
CONTROL	Indicator Lamp	8A2A9	2-55	Indicates sensitivity control is operable.
MOTOR	Fuse	8A2A9	2-55	Protects motor circuitry.
CONTROL	Fuse	8A2A9	2-55	Protects control circuitry.
ON/OFF	Switch	8A2A9	2-55	Turns the power to the regulator either on or off.

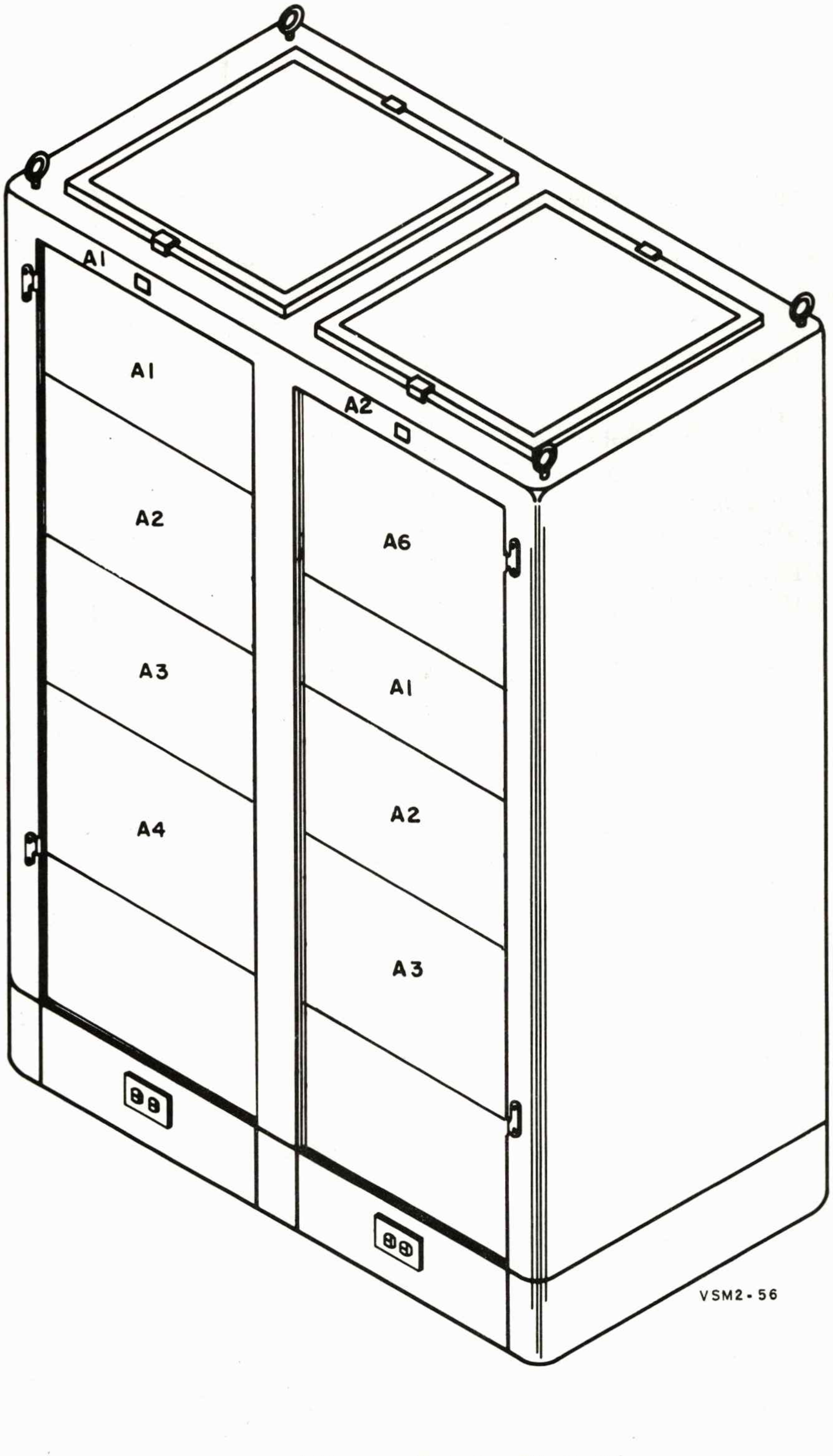
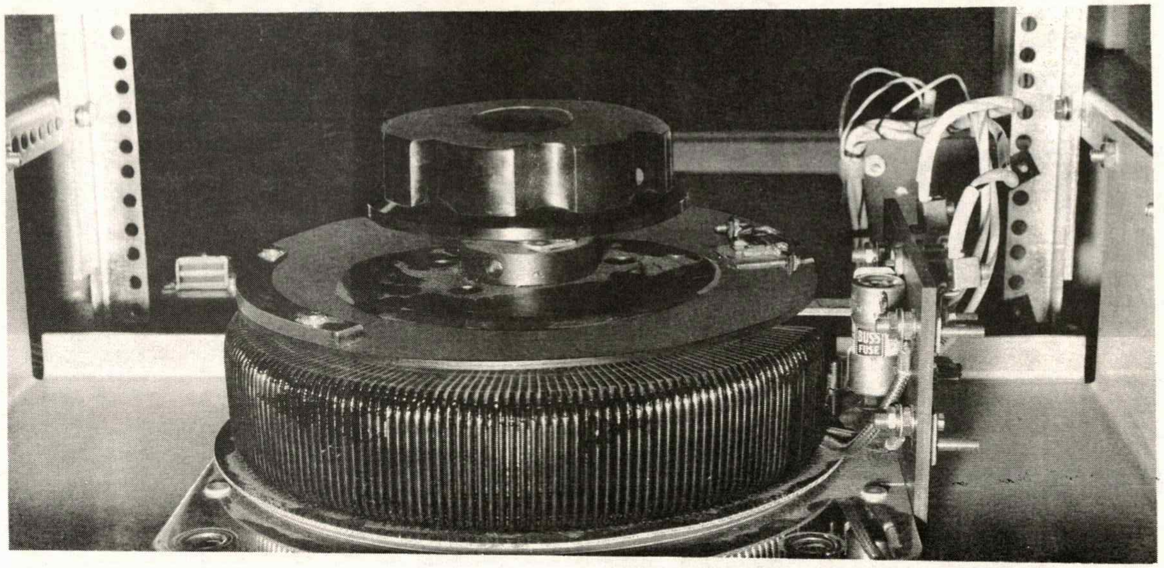


Figure 2-56. Unit 61

Table 2-57. Unit 61 Equipment Cabinet/Location of Panels (See figure 2-56)

Unit No.	Name	For Detail See Table No.	For Detail See Figure No.	Same as
61A1A1	Ballast Assembly	2-58	2-57	
61A1A2	Visual Display Power Control Panel	2-59	2-58	
61A1A3	3 Phase 60 CPS Protection	2-60	2-59	
61A2A2	400 CPS Protection	2-61	2-60	



VSM2-57

Figure 2-57. Unit 61A1A1 Ballast Assembly

Table 2-58. Unit 61A1A1 Ballast Assembly/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
Variac	Variable Transformer	61A1A1	2-57	Controls level of reflected light in model house.

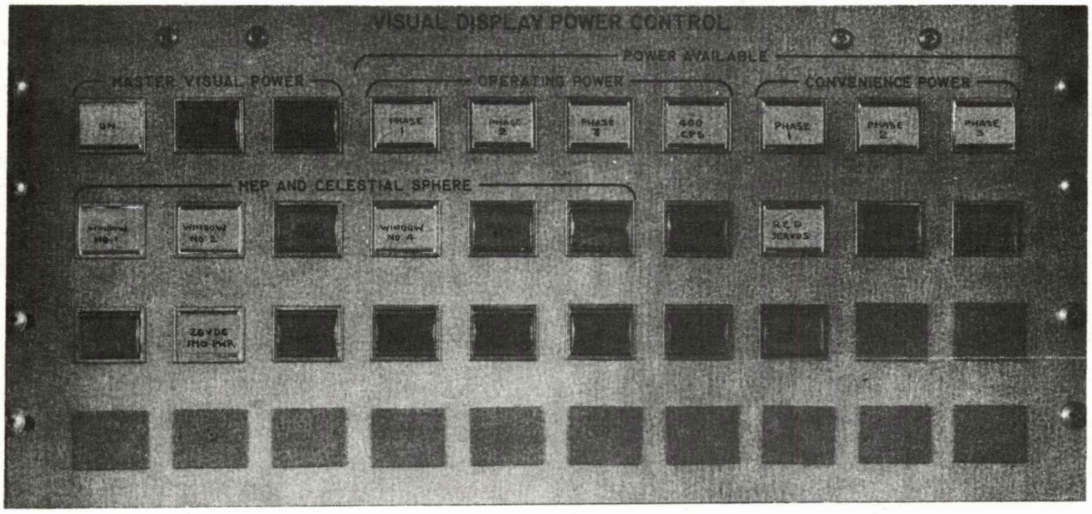


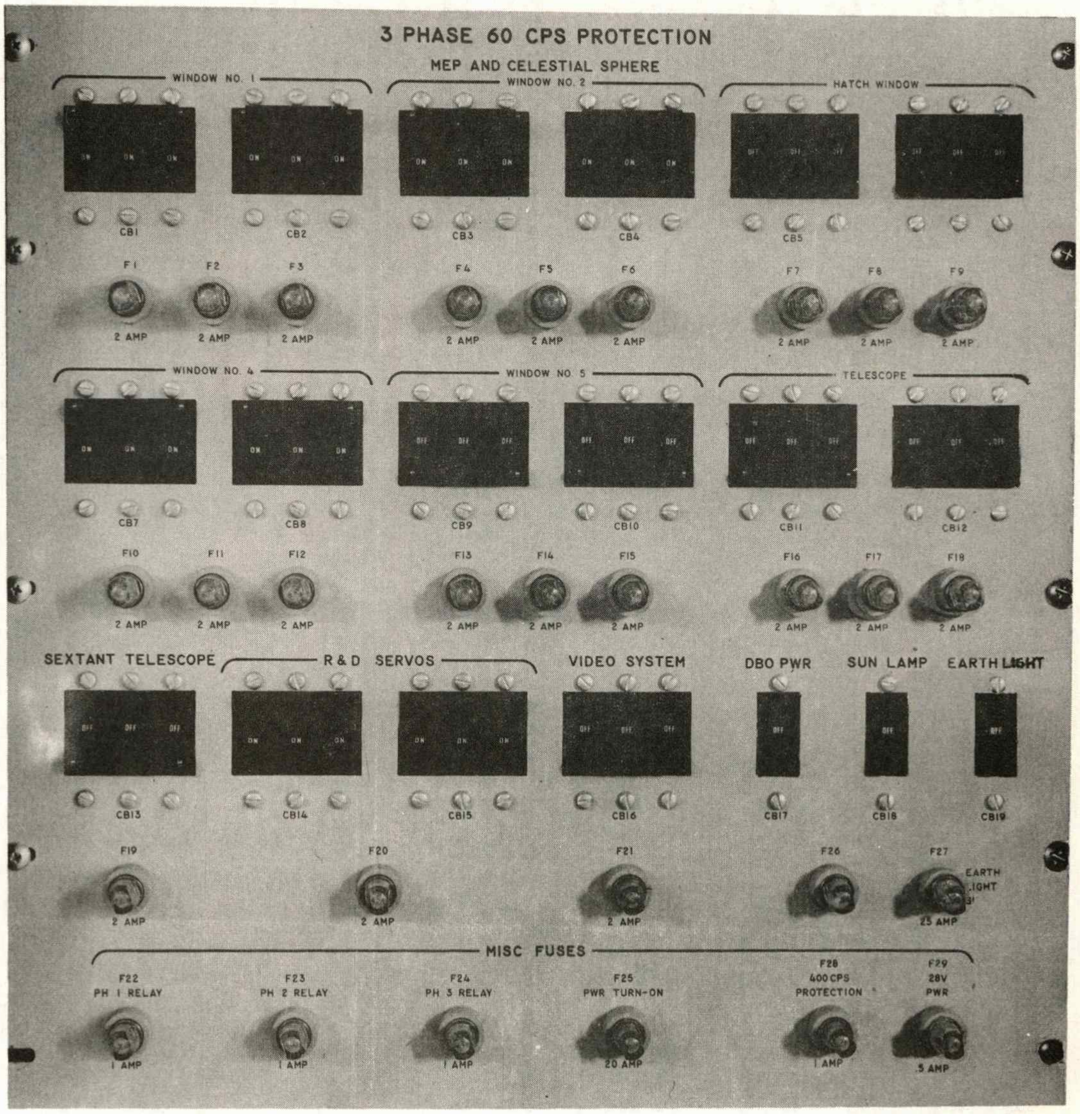
Figure 2-58. Unit 61A1A2 Visual Display Power Control Panel

Table 2-59. Unit 61A1A2 Visual Display Power Control Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
MASTER VISUAL POWER				
ON	Switch	61A1A2	2-58	Turns on power to power cabinet (Unit 61) when AMS primary sequencing is in the independent mode.
OFF	Switch	61A1A2	2-58	Removes power from the power cabinet.
MAINTENANCE IN PROGRESS	Light	61A1A2	2-58	Denotes that power is automatically turned off to the power cabinet and cannot be turned on from this panel.
OPERATING POWER				
PHASE 1	Light	61A1A2	2-58	Indicates the presence or absence of phase one of the 60 vps power.
PHASE 2	Light	61A1A2	2-58	Indicates the presence or absence of phase two of the 60 cps power.
PHASE 3	Light	61A1A2	2-58	Indicates the presence or absence of phase three of the 60 cps power.
400 CPS	Light	61A1A2	2-58	Indicates the presence or absence of 400 cps power in the power cabinet.
CONVENIENCE POWER				
PHASE 1	Light	61A1A2	2-58	Denotes the presence or absence of phase one of the convenience power.
PHASE 2	Light	61A1A2	2-58	Denotes the presence or absence of phase two of the convenience power.
PHASE 3	Light	61A1A2	2-58	Denotes the presence or absence of phase three of the convenience power.
MEP AND CELESTIAL SPHERE				
WINDOW NO. 1	Switch Light	61A1A2	2-58	Turns AC power to window display number one on or off.
WINDOW NO. 2	Switch Light	61A1A2	2-58	Turns AC power to window display number two on or off.
HATCH WINDOW	Switch Light	61A1A2	2-58	Inoperative.
WINDOW NO. 4	Switch Light	61A1A2	2-58	Turns AC power to window display number four on or off.
WINDOW NO. 5	Switch Light	61A1A2	2-58	Turns AC power to window display number five on or off.

Table 2-59. Unit 61A1A2 Visual Display Power Control Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TELESCOPE	Telescope	61A1A2	2-58	Turns AC power to the telescope display on or off.
Sextant - Telescope	Switch Light	61A1A2	2-58	Turns power to Sextant Telescope electronics cabinet (Unit 9) on or off.
R & D SERVOS	Switch Light	61A1A2	2-58	Turns power to the rendezvous and docking servo cabinet (Unit 6) on or off.
VIDEO SYSTEM	Switch Light	61A1A2	2-58	Turns power to the closed circuit television system on or off.
AIR COMPRESSOR	Switch Light	61A1A2	2-58	Turns power to the air compressor on or off even though primary power to the air compressor is supplied from a different source.
REG TV AC PWR	Light	61A1A2	2-58	Indicates that the automatic regulator (Stabiline) is turned on.
26 VDC IND PWR	Light	61A1A2	2-58	Denotes that the 26 volt power supply is on.
SUN LIGHT	Light	61A1A2	2-58	Indicates that AC power to the sun lights is on.
EARTH LIGHT	Light	61A1A2	2-58	Indicates that AC power to the earth lights is on.
MOON	Light	61A1A2	2-58	Indicates that AC power to the moon lights is on.
DC	Fail Light	61A1A2	2-58	Indicates failure of one or more of the DC power supplies used in the visual system.
400 CPS	Fail Light	61A1A2	2-58	Indicates that 400 cycle power is missing from one of the visual cabinets.



VSM2-59

Figure 2-59. Unit 61A1A3 3 Phase 60 CPS Protection

Table 2-60. Unit 61A1A3 3 Phase 60 CPS Protection/Control Functions

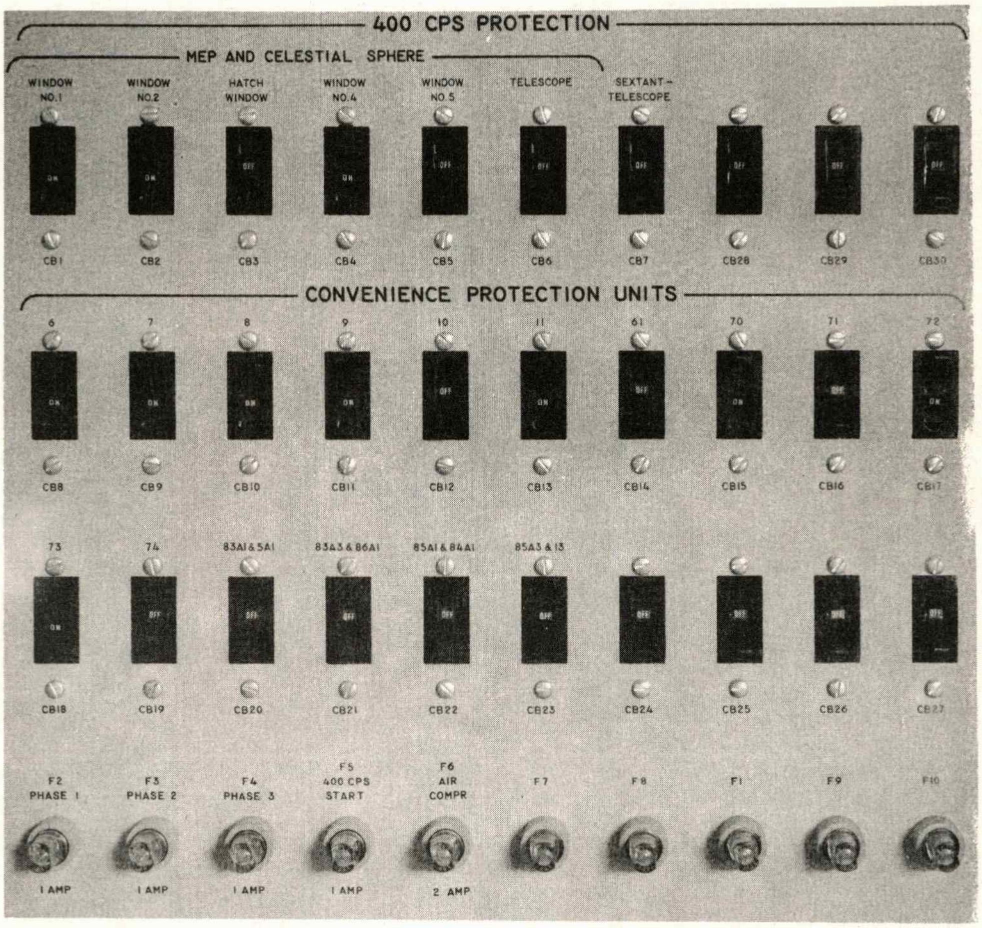
Control or Display	Description	Panel No.	Figure No.	Function
WINDOW NO. 1				
CB1, CB2	Circuit Breakers	61A1A3	2-59	Circuit-breaker type switches apply 3 phase ac power to window 1.
F1, F2, F3	Fuses	61A1A3	2-59	Indicating type fuse for each leg of 3 phase ac power supplied to window 1. Indicator light, incorporated into fuse, lights if fuse fails.
WINDOW NO. 2				
CB3, CB4	Circuit Breakers	61A1A3	2-59	Circuit-breaker type switches apply 3 phase ac power to window No. 2.
F4, F5, F6	Fuses	61A1A3	2-59	Indicating type fuse for each leg of 3 phase ac power supplied to window No. 2. Indicator light, incorporated into fuse, lights if fuse fails.
HATCH WINDOW				
CB5, CB6	Circuit Breakers	61A1A3	2-59	Not used.
F7, F8, F9	Fuse	61A1A3	2-59	Not Used.
WINDOW NO. 4				
CB7, CB8	Circuit Breakers	61A1A3	2-59	Circuit-breaker type switches apply ac power to window No. 4.
F10, F11, F12	Fuses	61A1A3	2-59	Indicating type fuse for each leg of 3 phase ac power supplied to window No. 4. Indicator light, incorporated into fuse, lights if fuse fails.
WINDOW NO. 5				
CB9, CB10	Circuit Breakers	61A1A3	2-59	Circuit breaker type switches apply ac power to window No. 5.
F13, F14, F15	Fuses	61A1A3	2-59	Indicating type fuse for each leg of 3 phase ac power supplied to window No. 5. Indicator light, incorporated into fuse lights if fuse fails.
TELESCOPE				
CB11, CB12	Circuit Breakers	61A1A3	2-59	Circuit-breaker type switches apply 3 phase ac power to telescope display equipment.
F16, F17, F18	Fuses	61A1A3	2-59	Indicator-type fuse for each leg of 3 phase ac power applied to the telescope display equipment. Indicator light, incorporated into the fuse, lights when fuse fails.
SEXTANT TELESCOPE				
CB13	Circuit Breaker	61A1A3	2-59	Circuit-breaker type switch applies 3 phase ac power to the sextant telescope display equipment.

Table 2-60. Unit 61A1A3 3 Phase 60 CPS Protection/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
F19	Fuse	61A1A3	2-59	Indicator type fuse protects ac power supplied to the sextant telescope displays. Indicator light, incorporated into the fuse, lights when fuse fails.
R & D SERVOS				
CB14, CB15	Circuit Breakers	61A1A3	2-59	Circuit-breaker type switches apply 3 phase ac power to the R and D servos.
F20	Fuse	61A1A3	2-59	Indicator type fuse protects ac power to the R and D servos. Indicator light, incorporated into fuse, lights when fuse fails.
VIDEO SYSTEM				
CB16	Circuit Breaker	61A1A3	2-59	Circuit-breaker type switch applies 3 phase ac power to the video system.
F21	Fuse	61A1A3	2-59	Indicator type fuse protects ac power supplied to the R and D servos. Indicator light, incorporated into the fuse, lights when fuse fails.
DBO PWR				
CB17	Circuit Breaker	61A1A3	2-59	Circuit-breaker type fuse applies power to the DBO system.
SUN LAMP				
CB18	Circuit Breaker	61A1A3	2-59	Circuit-breaker type switch applies ac power to sun lamp.
F26	Fuse	61A1A3	2-59	Indicator type fuse; indicator light incorporated into the fuse, lights if the fuse fails.
EARTH LIGHT				
CB19	Circuit Breaker	61A1A3	2-59	Circuit breaker type switch applies ac power to earth lamp.
F27	Fuse	61A1A3	2-59	Indicator type fuse; indicator light incorporated into the fuse, lights if the fuse fails.
MISC FUSES F22 PH1 RELAY	Fuse	61A1A3	2-59	Indicator type fuse protects the phase 1 relay. Indicator light, incorporated into the fuse lights if fuse fails.
F23 Fuse PH2 RELAY	Fuse	61A1A3	2-59	Indicator type fuse protects the phase 2 relay. Indicator light, incorporated into the fuse, lights if fuse fails.

Table 2-60. Unit 61A1A3 3 Phase 60 CPS Protection/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
F24 Fuse PH3 RELAY	Fuse	61A1A3	2-59	Indicator type fuse protects the phase 3 relay. Indicator light, incorporated into the fuse, lights if fuse fails.
F25 Fuse PWR TURN-ON	Fuse	61A1A3	2-59	Indicator type fuse protects ac power circuit. Indicator light, incorporated into the fuse, lights if fuse fails.
F28 Fuse	Fuse	61A1A3	2-59	Indicator type fuse protects 400 cps ac power circuit. Indicator light, incorporated into the fuse, lights if fuse fails.
F29 Fuse 28V PWR	Fuse	61A1A3	2-59	Indicator type fuse protects 28V circuits. Indicator light, incorporated into the fuse, lights if fuse fails.



VSM2-60

Figure 2-60. Unit 61A2A2 400 CPS Protection

Table 2-61. Unit 61A2A2 400 CPS Protection/Control Functions

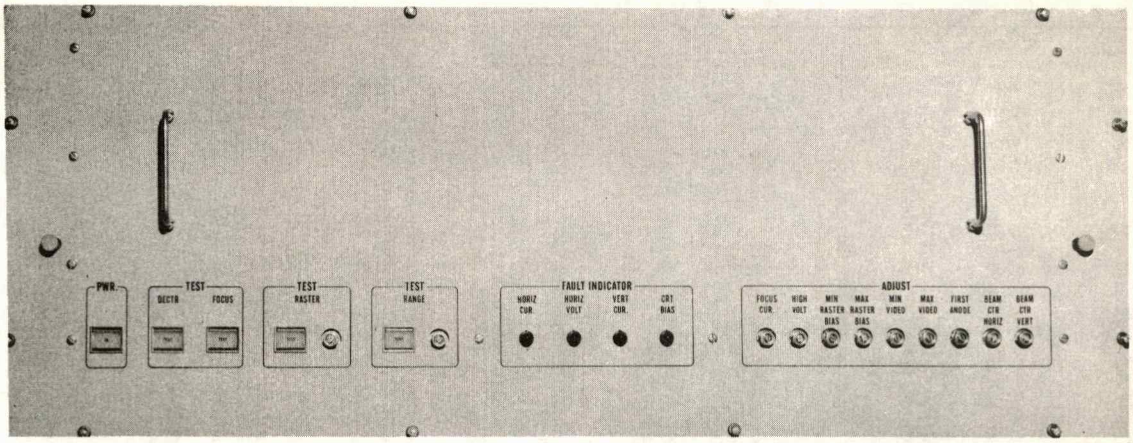
Control or Display	Description	Panel No.	Figure No.	Function
MEP AND CELESTIAL SPHERE				
WINDOW NO. 1				
CB1	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to window No. 1 equipment.
WINDOW NO. 2				
CB2	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to window No. 2 equipment.
HATCH WINDOW				
CB3	Circuit Breaker	61A2A2	2-60	Not used.
WINDOW NO. 4				
CB4	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to window No. 4 equipment.
WINDOW NO. 5				
CB5	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to window No. 5 equipment.

Table 2-61. Unit 61A2A2 400 CPS Protection/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
TELESCOPE	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to the telescope display equipment.
SEXTANT TELESCOPE	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to the Sextant telescope equipment.
CB28	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used.
CB29	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used.
CB30	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used.
CONVENIENCE PROTECTION UNITS				
6 CB8	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 6.
7 CB9	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 7.
8 CB10	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 8.
9 CB11	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 9.
10 CB12	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 10.
11 CB13	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 11.
61 CB14	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 61.
70 CB15	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used.
71 CB16	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used.
73 CB18	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to cabinet 73.

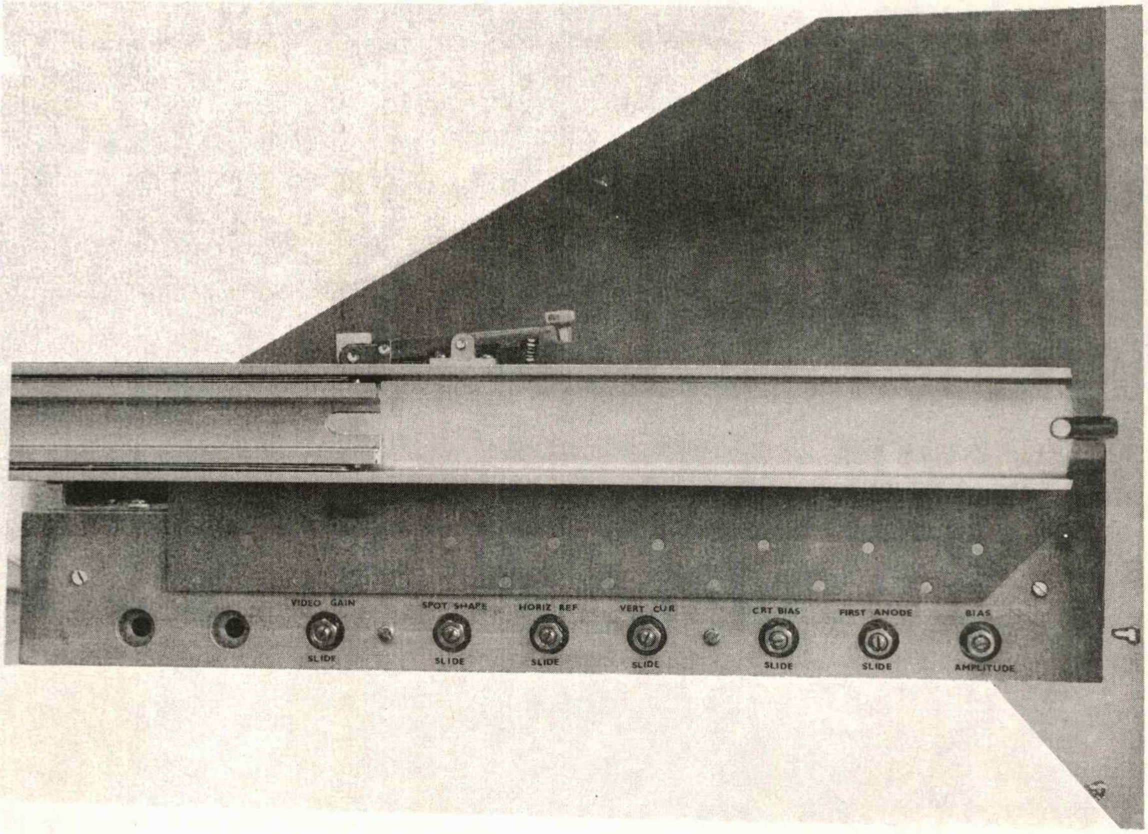
Table 2-61. Unit 61A2A2 400 CPS Protection/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
74 CB19	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for re[illegible]olling 400 cps power to cabinet 74.
83A1 & 5A1 CB20	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to units 83A1 and 5A1.
83A3 & 86A1 CB21	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to units 83A3 and 86A1.
85A1 & 84A1 CB22	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to units 85A1 and 84A1.
85A3 & 13 CB23	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Applies power and provides protection for relay controlling 400 cps power to units 85A3 and 13.
CB24	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used
CB25	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used
CB26	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used
CB27	Circuit Breaker	61A2A2	2-60	Circuit-breaker switch: Not Used
F2 PHASE 1	Fuse	61A2A2	2-60	Indicator type fuse protects the phase 1 leg of 3 phase power. Indicator light, incorporated into the fuse, lights if the fuse fails.
F3 PHASE 2	Fuse	61A2A2	2-60	Indicator type fuse protects the phase 2 leg of 3 phase power. Indicator light, incorporated into the fuse, lights if the fuse fails.
F4 PHASE 3	Fuse	61A2A2	2-60	Indicator type fuse protects the phase 3 leg of 3 phase power. Indicator light incorporated into the fuse, lights if the fuse fails.
F5 400 CPS START	Fuse	61A2A2	2-60	Provides protection for 400 cps starting circuits.
F6 AIR COMP	Fuse	61A2A2	2-60	Provides protection to air compressor circuits.
F7	Fuse	61A2A2	2-60	Not Used
F8	Fuse			
F1	Fuse			
F9	Fuse			
F10	Fuse			



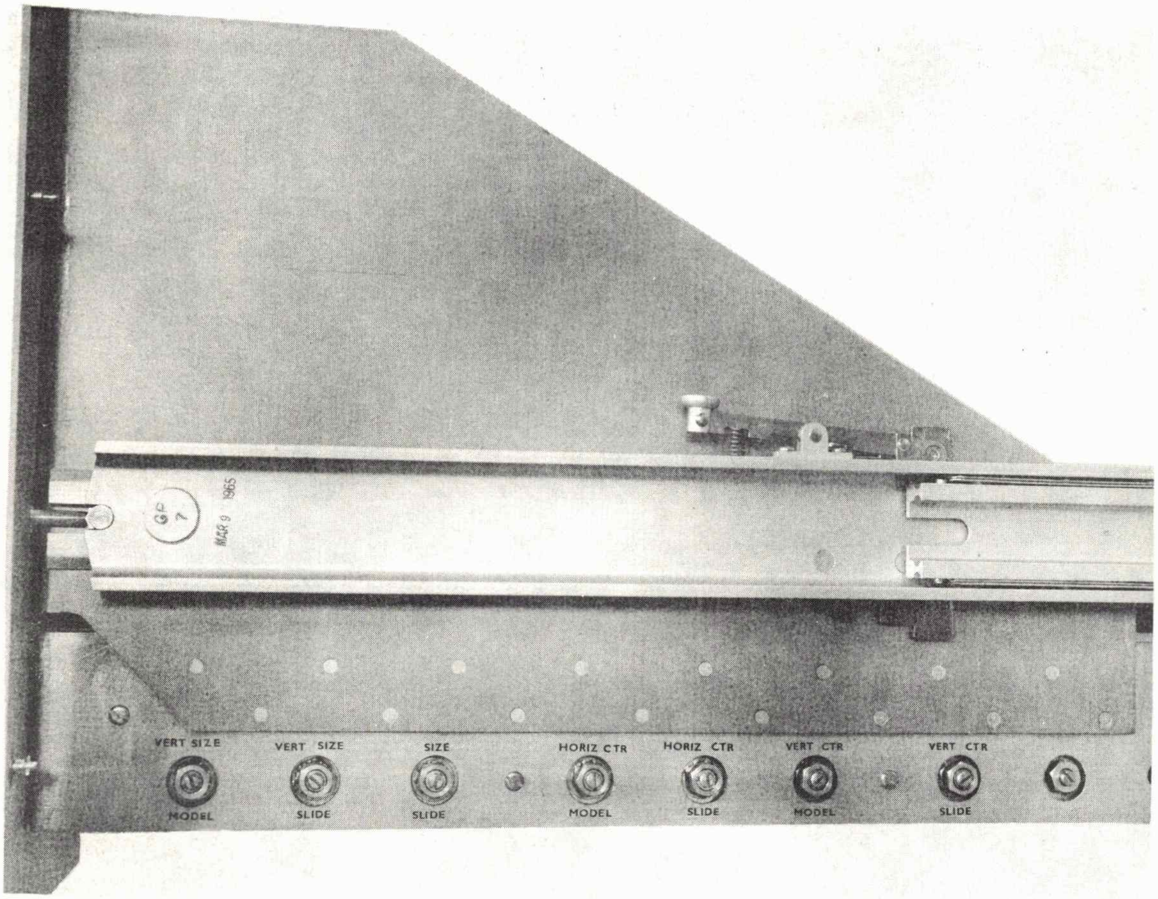
VSM2-61

Figure 2-61. CRT Control Panel



VSM2-62

Figure 2-62. CRT Control Panel



VSM2-63

Figure 2-63. Control Panel

Table 2-62. CRT Control Panel/Control Functions

Control or Display	Description	Panel No.	Figure No.	Function
PWR ON	Light Switch		2-61	Controls on-off power to unit.
TEST - DECTR	Indicator Switch		2-61	When turned on and light indicates on mode and the decentering inputs are grounded (for centering raster).
TEST - FOCUS	Indicator Switch		2-61	When switch is in on mode (light indicator on) a fixed focus current is modulated at 60 cycles/sec to the focus coil.
TEST - RASTER	Indicator Switch		2-61	Changes mode from automatic to test and applies a test reference voltage to the Sweep Loss Protector.
TEST - RASTER	Potentiometer		2-61	Controls a -50 to -150 volts to the horizontal size input.
TEST - RANGE	Indicator Switch		2-61	Sets range to test condition.
TEST - RANGE	Potentiometer		2-61	Allows for manual control of raster servo from minimum to maximum raster.
FAULT IND/HORIZ. CUR.	Indicator		2-61	Indicates loss of horizontal current.
FAULT IND/HORIZ. VOLT	Indicator		2-61	Indicates loss of horizontal voltage.
FAULT IND/VERT. CUR.	Indicator		2-61	Indicates loss of vertical current.
FAULT IND/CRT BIAS	Indicator		2-61	Indicates loss of CRT Bias.
ADJUST/FOCUS CUR.	Potentiometer		2-61	Controls the absolute value of focus current in the focus current coil.
ADJUST/HIGH VOLT	Potentiometer		2-61	Controls the 35KV anode voltage on the CRT.
ADJUST/MIN. RAST. BIAS	Potentiometer		2-61	Controls the minimum negative voltage on G1 (small raster end point).
ADJUST/MAX. RAST. BIAS	Potentiometer		2-61	Controls the maximum negative voltage on G-1 (large raster end point).
ADJUST/MIN. VIDEO	Potentiometer		2-61	Sets the end point of video level for small raster.
ADJUST/MAX. VIDEO	Potentiometer		2-61	Sets the end point of video level for large raster.
ADJUST/FIRST ANODE	Potentiometer		2-61	Sets maximum.
ADJUST/BEAM CTR HORIZ.	Potentiometer		2-61	Centers the electron beam in the horizontal plane.
VIDEO GAIN/SLIDE	Potentiometer		2-61	Controls the voltage to the Camera Control Unit for the adjustment of the Camera Control Units gain in the slide mode.
ADJUST/BEAM CTR HORIZ.	Potentiometer		2-61	Centers the electron beam in horizontal plane.

Table 2-62. CRT Control Panel/Control Functions (Cont)

Control or Display	Description	Panel No.	Figure No.	Function
SPOT SHAPE/SLIDE	Potentiometer		2-61	Controls the current through the spot shaper coil in the slide mode.
HORIZ. REF/SLIDE	Potentiometer		2-61	Controls the reference for the Sweep Loss Protection in the slide mode.
VERT. CUR./SLIDE	Potentiometer		2-61	Controls the Vertical Sweep Amplifier in the slide mode.
CRT BIAS/SLIDE	Potentiometer		2-61	Controls the negative voltage on G1.
FIRST ANODE/SLIDE	Potentiometer		2-61	Controls the positive voltage on G2 in the slide mode.
BIAS	Potentiometer		2-61	Controls the absolute level of negative voltage on G1.
PWR/ON	Light Switch		2-61	Controls on-off power to unit.
VERT SIZE/MODEL	Potentiometer		2-61	Sets the vertical current with respect to the horizontal current (aspect ratio).
VERT SIZE/SLIDE	Potentiometer		2-61	Set vertical current in slide mode (aspect ratio).
SIZE/SLIDE	Potentiometer		2-61	Sets absolute raster size for slide mode (Horizontal and vertical simultaneously).
HORIZ CTR/MODEL	Potentiometer		2-61	Centers raster in horizontal plane while in model mode.
HORIZ. CTR/SLIDE	Potentiometer		2-61	Centers raster in horizontal plane while in slide mode.
VERT. CTR/MODEL	Potentiometer		2-61	Centers raster in vertical plane while in model mode.
VERT. CTR/SLIDE	Potentiometer		2-61	Centers raster in vertical plane while in slide mode.
SLP/LEVEL	Potentiometer		2-61	Sets sweep loss level for CRT bias.

2-13. COMPUTER ORIENTED FUNCTIONAL TEST.

2-14. When a complete test of the AMS visual system is required, testing by computer program is recommended. The visual system diagnostics, program No. 61, consists of five major routines and a control (monitor) program. Each routine contains numerous test subroutines designed to isolate malfunctions to a particular section of the equipment, the devices associated with the function being performed, and the transmission channels used for receiving the data from the particular subsystem. The control (monitor) routine is stored on magnetic tape along with the five previously mentioned major routines. The operational system and the diagnostic system cannot be conducted simultaneously. If a malfunction occurs such that the diagnostic system must be called in, the mission must be aborted. In effect, the visual system diagnostics are to be used only in the off-line phase of simulator maintenance and repair. It is recommended that a complete programmed computer test be done on the AMS visual system prior to each 350-hour mission.

2-15. VISUAL SYSTEM DIAGNOSTICS (PROGRAM NO. 61).

2-16. The visual system non-computer, off-line diagnostics are designed to exercise and test the AMS output devices and their channels external to the DDP-224 computer complex. The tests, as designed, require the manual assistance of the maintenance personnel to examine the outputs (and/or their effects) and to initiate the controlling typewriter commands.

2-17. The visual system diagnostics, program No. 61, consists of five major routines and a control (monitor) program. Each major routine is stored on magnetic tape and consists of test subroutines to isolate malfunctions to a particular section of the equipment, to devices associated with the function being performed, and to transmission channels used for receiving the data from the particualr subsystem. The control (monitor) routine is also stored on the magnetic tape with the five previously mentioned major routines.

2-18. The operational system and the diagnostic system cannot be conducted simultaneously. If a malfunction occurs such that the diagnostic system must be called in, the mission must be aborted. In effect, the visual system diagnostics are to be used only in the off-line phase of simulator maintenance and repair.

2-19. DIAGNOSTIC CONTROL MONITOR. Program No. 61 utilizes the visual diagnostic control routine and one or more of the five system routines (S, X, R, V, M) to provide the test capability. The five system routines are stored on magnetic tape, along with the control monitor routine, as separate files. In order to use the diagnostic system, it must be loaded into core and addressed according to the operating procedure. The typewriter is utilized by the control routing for test routine call-up from tape.

2-20. DIAGNOSTIC OPERATING INSTRUCTIONS FOR PROGRAM NO. 61. The following procedures describe the loading instructions for the visual systems diagnostics, program No. 61.

a. Place AMS system tape on any MTU (magnetic tape unit) available and "ready" the unit.

b. Press MASTER CLEAR.

c. Execute OCP 53-26150, then RESET. (Do not MASTER CLEAR!)

d. Place AMS bootstrap in card reader and "ready" the reader.

e. Press FILL button (on computer).

f. When computer halts, press MASTER CLEAR.

g. Place the number of the MTU containing the system tape in the first three bits of the A register as shown below (X indicates ON).

MTU No.	Bit No. 1	2	3
1	X	O	O
2	O	X	O
3	X	X	O
4	O	O	X

h. Place all SSW switches "down" and press START button.

i. After system tape has been read into the computer, press MASTER CLEAR.

j. Set A register to $70{,}000_8$ (bits 10, 11, and 12 on), and place MTU number in first 3 bits as described in step g.

k. Set Program register to 11 (bits 21 and 24 ON).

l. Press START and typewriter will type SELECT.

m. Type the word ABS LOAD and press carriage return.

n. System tape will load ABS LOAD at location $70{,}000_8$ and the typewriter will type READY.

o. Place diagnostic program No. 61 on any available MTU and "ready" the unit.

p. Set A register to the number of the MTU containing the diagnostic program No. 61 (refer to step g).

q. Set the Program register to $70{,}000_8$ (bits 21 and 24).

r. Press START. When tape loading is completed, typewriter will type LOADING COMPLETE 62114.

s. Press MASTER CLEAR and ensure that RT1 and INT switches are in the "ON" position.

t. Set Program register to 200_8.

u. Press START. Typewriter will print SELECT TESTS.

v. Type in the control word message desired.

2-21. Control Word Message. The control word message is group of alpha-numberic characters (symbols) that set the requirements for the diagnostic test subroutines. This message is typed by the operator at the console typewriter and causes the test subroutine selected to be initialized and set into operation.

2-22. Control Word Format. The following is the format to be used in typing in the control word message for program No. 61.

a. First Symbol. The first symbol describes the name of the system to be used to exercise the visual hardware. The possible input codes are:

1. S - Starfield system
2. X - Sextant and telescope system
3. R - Rendezvous servo system
4. V - Rendezvous video system
5. M - Mission effects projector system

b. Second Symbol. The second symbol describes the number of the test to be used to exercise the visual hardware. Refer to table 2-63 to obtain the proper number. (An example of the first and second symbol is S1. This means you are utilizing the starfield system's test number one.

c. Comma.

d. Third Symbol. The third symbol describes the first parameter of the test to be used to exercise the visual hardware. The first parameter must contain both an integer value and a decimal value (i.e., 9.8, 10.3, 0.7, or 3.0). Refer to table 2-63.

e. Comma.

f. Fourth Symbol. The fourth symbol describes the second parameter of the test to be used to exercise the visual hardware. The second parameter must contain both an integer value and a decimal value (i.e., 9.8, 10.3, 0.7, or 3.0). Refer to table 2-63.

g. Comma.

h. Last Symbol. After all the desired tests are selected and entered along with their proper parameters, the last symbol $ (a dollar sign) is entered.

2-23. An example of a single test control word entry is as follows: S5, 25.2, 141.006, $.

2-24. The third symbol (first parameter) of the control word is either a rate of change or a time delay depending on the requirements of the individual test. If the test is an initialization test, the third symbol (first parameter) is 0.0.

2-25. The fourth symbol (second parameter) of the control word is the desired freeze point or hold point. The computer will drive the hardware to this point, enter a freeze state, and hold the equipment in position until directed to continue. The parameter 0.0 signifies no freeze point. Thus, it is not possible to freeze a test exactly at 0.0.

NOTE

> In reference to the third and fourth symbols (first and second parameters). The program has not been designed to reject a parameter that is not within the specified range for each individual test (refer to table 2-63). Consequently, if an out of range parameter is used, the result will be unpredictable.

2-26. The dollar sign (last symbol) causes the test to begin.

2-27. Programmable Stops (Freeze Points). When any test reaches a programmable stop (freeze point), a message containing the test name followed by TEST FREEZE STOP is typed out on the console typewriter, and the computer halts. In order to continue the test after the freeze stop has occurred, the following formate is to be used.

a. First Symbol. The first symbol is an F to signal the computer that a new freeze point is to be entered.

b. Comma.

c. Second Symbol. The second symbol describes the new second parameter or new freeze point. If no new freeze point is desired, the symbol 0.0 is typed in.

d. Comma.

2-28. An example of the format used to continue the test after a programmable stop has occurred is as follows: F, 150.0, or F, 0.0.

2-29. The tests will be resumed as soon as the final comma has been typed.

2-30. Test Completion. When the requested tests have been completed, a TESTS COMPLETED message followed by a SELECT TESTS message, will be typed out on the console typewriter. New tests can then be entered via the console typewriter following the procedure mentioned previously.

2-31. Multiple Testing. In order to run several (two or more) tests simultaneously, the following format (referring to the control word format, paragraph 2-22) is to be used:

a. First Symbol. The first symbol (name) of the first test.

b. Second Symbol. The second symbol (test number) of the first test.

c. Comma.

d. Third Symbol. The third symbol (first parameter) of the first test.

e. Comma.

f. Fourth Symbol. The fourth symbol (second parameter) of the first test.

g. Comma.

h. Fifth Symbol. The first symbol (name) of the second test.

i. Sixth Symbol. The second symbol (test number) of the second test.

j. Comma.

k. Seventh Symbol. The third symbol (first parameter) of the second test.

l. Comma.

m. Eighth Symbol. The fourth symbol (second parameter) of the second test.

n. Comma.

o. . . . .ETC. Continue entering tests until all desired tests are entered.

p. Last Symbol. A $ (dollar sign) is typed in after all the desired tests along with their appropriate parameters have been entered. The dollar sign begins the testing.

2-32. An example of multiple testing control word format is as follows: X20, 35.0, 0.0, R2, 3.2, 6.2, V12, 0.0, 0.0, ... ,$

2-33. SPECIAL CONTROL WORD COMMAND MESSAGES. The following special control word messages are used when it is desired to change a parameter or to start a new test after a freeze stop has occurred:

a. In order to change a parameter (before a test has begun or has been resumed), type in a # (pound sign), then re-type the parameter.

b. In order to begin a new test after a freeze stop has occured, type in a $ (dollar sign). The typewriter will, in turn, type out a SELECT TESTS message and the new test can be entered via control word format.

2-34. Error Messages. The visual system diagnostic routines cause the typewriter to output the following messages if an error occurs in the control word message:

a. INCORRECT PARAMETER is typed out if an error was made in entering a parameter. To correct the error, re-type the parameter and continue typing the control word message to the end.

b. COMMAND ERROR is typed out if an error was made in entering a command. To correct the error, re-type the control word message from the beginning.

c. INCORRECT DEVICE NAME is typed out if an error was made in entering a device name. To correct the error, re-type the control word message from the beginning.

2-35. PROGRAM OPERATING PROCEDURES. To familiarize maintenance personnel with the utilization of program No. 61, a detailed procedure for the MEP subsystem is presented in table 2-63, MEP Computer Test. For this procedure, specific parameters are listed, however, unless otherwise noted, any allowable parameters (first parameter and freeze point) may be used. Table 2-64, MEP Computer Test Parameters, provides supporting information (parameter limits, DCE device, program symbol, etc.) to further assist personnel in performing the test, or isolating a malfunction.

2-36. Test descriptions and supporting data for the remaining four subsystems are listed in tables 2-64 through 2-67. They are performed in the same manner as described for the MEP.

2-37. Each test is indexed by a reference number (Ref. No.). When a reference number appears with an alphabet character, it is advisable to begin the test at the letter A and run the test through to the last most character.

Table 2-63. Mission Effect Projector Computer Test

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
1	MEP Initialization	All device channels associated with the MEP are set to their initial positions	Do not run any other tests simultaneously with this test. CAUTION Do not stop computer while test is in progress as this may cause interlocks to be triggered.	M1, 0.0, 0.0, $	Initialization requires approximately 11 minutes to complete. Indexing each of the 2 turrets of an MEP requires approximately 5 minutes and 10 seconds.
2	Quick Dissolve, Turret No. II	Activates the quick dissolve mirror drive to change from one optical path to another	Second parameter is always 0.0	M2, 1.0, 0.0, $	Telescope and window earth scenes dissolve from turret No. II to turret No. II
3	Solar Blanking		Manually set blanking shutter to position	(None)	Initialization will cause solar image to appear superimposed on the earth scene (test pattern). Solar image must be blanked out manually before proceeding.
4	Earth/Moon Illumination Varifocal and Angenieux Varifocal, Turret No.II	Verification of test pattern centering.		(None)	Initialization should have centered test pattern. If the test pattern is not centered, perform the following: a. Place all film drives in manual and manually center test pattern in cassette II of each MEP. b. Verify that the number of 2MM gradients appear as described below (include the circumference of the circle as the first gradient):

	Top and Bottom	Each Side
RDV Windows	4	5
Landing Windows	2	5
Telescope	3	3

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
4 (Cont)					c. Manually adjust illumination varifocal to maximum altitude and leave in manual mode.
5A	Angenieux Verifocal, Turret No. II, Normal Rate	Activates the Angenieux lens at the normal rate (2500 ft./sec.) to maximum altitude scene (215.4 N.M.).		M10, 2500.0, 215.4, $	a. Image of test pattern will decrease in size. Freeze stop will occur approximately 2 minutes and 40 seconds after control word is initialized. b. After freeze stop, verify that the minimum number of 2 MM gradients are visible (unless occulted by edge of window) as follows: Top and Bottom — Each Side RDV Windows 8 12 Landing Windows 5 11 Telescope 7 7
5B	Angenieux Reset	Return to minimum.		F, 0.0	Image will increase to original size while FOV decreases.
6A	Illumination Varifocal, Turret No. II	Pre-test setup.	Manually set illumination varifocal to lowest simulated altitude and place in automatic mode. Place Angenieux to manual mode and set to maximum altitude.		Center portion of earth scene should be illuminated.
6B	Normal Rate	Activates the illumination varifocal at the maximum normal rate (2500 ft./sec.) to the maximum altitude scene (215.4 N.M.).		M6, 2500.0, 215.4, $	Illuminated area will increase in size until entire earth scene is completely lighted. Freeze stop should occur approximately 2 minutes and 40 seconds after control word is initialized.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
6C		Return to minimum.		F, 0.0	a. Illuminated area will return to the scene described in Ref. No. 6A. b. After test, set Angenieux to minimum simulated altitude and place in automatic mode.
7A	Earth and Moon, Illumination and Angenieux, Turret No. II, Normal Rate	Activates the illumination and Angenieux varifocals simultaneously at the normal rate, to the maximum altitude scene (215.4 NM).	Verify that both varifocals are set to minimum before typing control word.	M6, 2500.0, 215.4, M10, 2500.0, 215.4, $	Image size will decrease while the FOV area increases.
7B		Return to minimum setting.		F, 0.0	Image will return to original size (minimum altitude) while entire scene remains illuminated.
8	Earth and Moon, Illumination and Angenieux Lens, Fast Rate	Activates the illumination and Angenieux varifocals simultaneously at the fast rate to maximum altitude scene, and return to the minimum.	No freeze stops.	M5, 2500.0, 0.0, M9, 2500.0, 0.0, $	FOV and illumination will increase to maximum, then return to minimum.
9	Orbital Film, Off Course, Turret No. II	First parameter is rate of motion to ground track corresponding to film centerline in NM/min. Second parameter is distance from ground track at which freeze stop occurs.	a. Ensure that orbital cassettes II a and II c are in the automatic mode. b. No freeze stops.	M21, 307.0, 0.0, $	Earth scene will move to left, and then to right. Elapsed time: approximately 9 minutes and 40 seconds. NOTE Error voltage should not build up.
10A	Reset Turret No. IIA, Orbital Film Drive	Orbital film drive, Turret No. IIA is driven to the reset position.	Ensure that cassettes IIA and IIC are in the automatic mode.	M26, 0.0, 0.0, $	Test pattern will be set to center position of reticle.
10B	Orbital Film Drive, Turret No. IIA, Normal Rate	Orbital film drive is cycled through one orbit at the maximum normal rate (14.71 degrees per second).	Scale factor: 0.1287 degrees of servo per NM Film scale: 8.77 NM per MM	M24, 14.71, 0.0, $	Film will advance orbit (20,493 NM). Elapsed time: approximately 2 minutes and 25 seconds.
10C	Orbital Film Drive, Turret No. IIA, Fast Rate	Orbital film drive is cycled through one orbit at the maximum fast rate (25.0 degrees per second).	(Refer to Ref No. 10B)	M22, 25.0, 0.0, $	Film will advance 1 orbit in approximately 1 minute and 46 seconds.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
10D	Orbital Film Drive, Turret No. IIA, Reverse	Orbital film drive is cycled through one orbit in the reverse direction.	(Refer to Ref. No. 10B)	M28, 25.0, 0.0, $	Film will complete 1 orbit in the reverse direction, in approximately 1 minute and 46 seconds.
10E	Reset Turret No. IIA	Orbital film drive, turret No. IIA is reset (refer to Ref. No. 10A).		M26, 0.0, 0.0, $	Film will stop with test pattern centered at the reticle.
11	Turret No. II Indexing	Positions cassette A or C. If first parameter is 0.0, cassette A will be positioned in optical path. Conversely, if the first parameter is 1.0, cassette C will be positioned in the optical path. Second parameter is always 0.0 (no freeze stop).	Cassette A should be in the optical path prior to test. CAUTION Do not use freeze stops as this may cause interlocks to be triggered.	M33, 1.0, 0.0, $	Cassette C will be positioned and centered in optical path. Elapsed time: approximately 5 minutes and 10 seconds.
12	Orbital Film Drive, Turret No. IIC, Normal Rate	Orbital film drive is cycled through 1 orbit at the maximum normal rate (14.71 degrees per second).	(Refer to Ref. No. 10A)	M25, 14.71, 0.0, $	Film will advance one orbit in approximately 2 minutes and 25 seconds.
13	Orbital Film Drive, Turret No. IIC, Fast Forward	Orbital film drive is cycled through 1 orbit at the maximum fast rate (25 degrees per second).		M23, 25.0, 0.0, $	Film will advance 1 orbit in approximately 1 minues and 25 seconds.
14	Orbital Film Drive, Turret No. IIC, Fast Reverse	Orbital film drive is cycled through orbit in the reverse direction at the maximum fast rate.		M29, 25.0, 0.0, $	Film will complete one orbit in the reverse direction in approximately 1 minute and 25 seconds.
15	Orbital Film Drive, Turret No. IIC, Reset	Orbital film drive is driven to the reset position.		M27, 0.0, 0.0, $	Film will return to starting position with test pattern centered at the reticle.
16	Spherical Distortion	First parameter is the delay time in seconds, after typing the control word, that will elapse before the spherical distortion lens is introduced into the optical path. Second parameter is the time, in seconds, that the spherical distortion lens remains in the optical path.		M34, 10.0, 60.0, $	For this control word, the spherical distortion lens will enter the optical path 10 seconds after the control word is initialized, and remain for 60 seconds before it is removed.

Table 2-63. Mission Effect Projector Computer Test (Cont)

<table>
<tr><th>Ref. No.</th><th>Test Title</th><th>Test Description</th><th>Test Conditions</th><th>Control Word</th><th>Results</th></tr>
<tr><td>17</td><td>Turret No. I Indexing and Quick Dissolve</td><td>Positions cassette A or C. If first parameter is 0.0, cassette A will be positioned in optical path. Conversely, if the first parameter is 1.0, cassette C will be positioned in the optical path. Second parameter is always 0.0 (no freeze stop).</td><td>Do not run this test simultaneously with another test containing a freeze stop or an error message will result.</td><td>M32,1.0,0.0, $</td><td>Cassette C will be positioned and centered in the optical path. Elapsed time: approximately 5 minutes and 10 seconds.</td></tr>
<tr><td>18</td><td>Turret No. I, Cassette C, Reset</td><td>Trans-earth/lunar film drive, turret No. IC is driven to reset position.</td><td>Both parameters are always 0.0.</td><td>M31, 0.0, 0.0, $</td><td>Test pattern should be centered in FOV. If test pattern is not centered, set film drive to manual mode and center each MEP manually and leave film drives in manual mode.</td></tr>
<tr><td>19</td><td>Earth/Moon Illumination Varifocal and Angenieux Varifocal, Turret No. I</td><td>Verification of test pattern centering.</td><td></td><td>(None)</td><td>a. Verify that the number of 2 MM gradients appear as described below (include the circumference of the circle as the first gradient):
<table>
<tr><th></th><th>Top and Bottom</th><th>Each Side</th></tr>
<tr><td>RDV Windows</td><td>4</td><td>5</td></tr>
<tr><td>Landing Windows</td><td>2</td><td>5</td></tr>
<tr><td>Telescope</td><td>3</td><td>3</td></tr>
</table>
b. Manually adjust illumination varifocal to maximum altitude and leave in manual mode.</td></tr>
<tr><td>20A</td><td>Angenieux Varifocal, Turret No. I, Normal Rate</td><td>Activates the Angenieux lens at the normal rate (2500 ft./sec.) to maximum altitude scene (215.4 NM).</td><td></td><td>M8, 2500.0, 215.4, $</td><td>a. Image of test pattern will decrease in size. Freeze stop will occur approximately 2 minutes and 40 seconds after control word is initialized.

b. After freeze stop, verify that the minimum number of 2 MM gradients are visible (unless occulted by edge of window) as follows:</td></tr>
</table>

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results	Top and Bottom	Each Side
20A (Cont)							
					RDV Windows	8	12
					Landing Windows	5	11
					Telescope	7	7
20A	Angenieux Reset	Return to minimum.		F, 0.0	Image will return to original altitude size while FOV decreases.		
21A	Illumination Varifocal, Turret No. II	Pre-test set-up.	Place illumination varifocal in automatic mode, Angenieux in manual mode. Manually adjust Angenieux to maximum altitude position.		Center part of scene will be illuminated.		
21B		Activates the illumination varifocal at the normal rate (2500 ft./sec.) to the maximum altitude scene (215.4 NM).		M4, 2500.0, 215.4, $	Illuminated area will increase in size until entire scene is completely lighted. Freeze stop should occur approximately 2 minutes and 40 seconds after the control word is initialized.		
21C		Return to minimum.		F, 0.0	a. Illuminated area will return to the scene described in Ref. No. 21A. b. After test, set Angenieux to minimum simulated altitude and place in automatic mode. Entire scene should be lighted.		
22A	Illumination and Angenieux, Turret No. I, Normal Rate	Activates the illumination and Angenieux varifocals simultaneously at the normal rate to the maximum altitude scene (215.4 NM).	Verify that both varifocals are set to minimum.	M4, 2500.0, 215.4, M8, 2500.0, 215.4, $	Image size will decrease while the FOV area increases. Entire scene should be lighted.		
22B		Return to minimum setting.		F, 0.0	Image will return to original size (minimum altitude) while entire scene remains illuminated.		

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
23	Illumination and Angenieux lens, Turret No. I Fast Rate	Activates the illumination and Angenieux varifocals simultaneously at the fast rate to the maximum scene, and return to the minimum.	No freeze stops.	M3, 2500.0, 0.0, M7, 2500.0, 0.0, $	Scene will decrease in size and then increase to original size while entire scene remains illuminated. Elapsed time: Approximately 5 minutes and 20 seconds.
24	Orbital Film, Off Course, Turret No.I	First parameter is rate of motion to ground track corresponding to film centerline in NM/min. Second parameter is distance from ground track at which freeze stop occurs.	No freeze stops.	M20, 307.0, 0.0, $	Earth scene will move to left, and then to right. Elapsed time: approximately 9 minutes and 40 seconds. NOTE Error voltage should not build up.
25A	Reset Turret No. I C, Trans-Earth/Lunar Drive	Trans-earth/lunar film drive, turret No. I C is driven to reset position.	a. Ensure that film drive is in automatic mode. b. Both parameters are always 0.0.	M31, 0.0, 0.0, $	Test pattern will be set to center position of the reticle.
25B	Turret No. I C, forward, one frame, maximum rate	First parameter is film servo rate in degrees per second. Maximum programmable servo rate is 64.8 degrees per second (1 frame).	Second parameter is always 0.0 (No freeze stops)	M30, 64.8, 0.0, $	Film will advance 1 complete frame (64.8 degrees of servo rotation) in 1 second.
25C	Turret No. I C, forward, slow rate	Same as Ref. No. 25B except that rate is 1 degree per second.	Refer to Ref. No. 25B	M30, 1.0, 0.0, $	Film will advance 1 complete frame in 64.8 seconds. Verify that film movement is smooth through whole cycle.
25D	Reset Turret No. I C	Trans-earth/lunar film drive, turret No. I C is returned to reset position.	Both parameters are always 0.0	M31, 0.0, 0.0, $	Film will return to reset position with test pattern centered in reticle.
26	Spherical Distortion, Turret No. I	First parameter is the delay time in seconds, after typing the control word, that will elapse before the spherical distortion lens is introduced into the optical path. Second parameter is the time, in seconds, that the spherical distortion lens remains in the optical path.		M34, 5.0, 30.0, $	For this control word, the spherical distortion lens will enter the optical path 5 seconds after the control word is initialized, and remain for 30 seconds before it is removed.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
27A	Day-Night Terminator Drives, Fast Rate	First parameter is rate of shuttle movement in MM (millimeters) per second. Second parameter is freeze stop in MM per second. Rate is a function of altitude, orbital velocity and inclination.		M13, 6.1, 0.0, $	Earth scene or test pattern will be blanked, unblanked, then blanked again, with the terminator entering the scene from the opposite side and continuing through until the scene is visible again. Eleapsed time: approximately 33 seconds.
27B	Day-Night Terminator Drives, Normal Rate	Same as Ref. No. 27A except that additional hardware is involved		M14, 6.1, 0.0, $	Same as Ref. No. 27A except for rate.
28A	Day-Night Terminator, Angular Drives	First parameter is rate of terminator rotation in FOV, measured in degrees per second. Second parameter is the angle at which the freeze stop occurs.	Set terminator time drive to manual mode. Adjust terminator to blank out half of earth scene.	M15, 5.0, 90.0, $	Terminator should rotate 90 degrees from starting point at the rate of 5 degrees per second. Elapsed time: approximately 18 seconds.
28B	Full Range	Terminator is rotated through the full range.		F, -90.0	Terminator will rotate 180 degrees in the opposite direction in approximately 36 seconds.
28C	Reset	Terminator is returned to the starting position.		F, 0.0	Terminator will rotate 90 degrees and return to original position in approximately 18 seconds.
28D	Slow Speed	Terminator is rotated 30 degrees.		M15, 0.5, 30.0, $	Terminator will rotate 30 degrees from starting point at the rate of 0.5 degrees per second. Elapsed time: approximately one minute.
28E	Reset	Terminator is returned to the starting point.		a. $	This symbol will clear the computer and cause SELECT TESTS to be printed at the output typewriter.
				b. M15, 5.0, 0.0, $	Terminator will return to the starting position at the rate of 5 degrees per second. Elapsed time: approximately six seconds.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
29A	Extended Range, Off Course, Normal Rate	Causes occultation of earth scene by cloud cover. First parameter is the rate of travel in millimeters per second (MM/sec.), of the ring mirror. Second parameter is the position of the ring mirror, with respect to the center, measured in millimeters.		M12, 0.828, 27.94, $	Cloud cover will enter earth scene (or test pattern) after the control word is initialized. Scene will be completely occulted in approximately 34 seconds.
29B	Full Cycle	Full transition of transboundary servos.	Freeze stop at extreme of mirror travel.	F, -27.94	Cloud cover will be removed from earth scene (or test pattern) and reappear from opposite side of view. Transition will continue until scene is again completely occulted. Elapsed time: approximately 68 seconds.
29C	Reset	Remove cloud cover.	No freeze stops.	F, 0.0	Cloud cover will be removed from scene.
30	Extended Range, Off Course, Fast Rate	Same as Ref. No. 29B except that fast rate is utilized.		M11, .838, 0.0, $	Cloud cover will enter the scene, fully occult, then recede from the scene. This view will then be repeated with the cloud cover entering from the opposite side and continue until the scene is clear again. Elapsed time: approximately 2 minutes and 18 seconds.
31A	Transboundary and Earth Blanking, and Sunrise Annuli	Pre-test setup.	Set yaw servo to manual and adjust so that earth scene, starfield and clouds are visible.	(None)	
31B	Transboundary Blanking	First parameter is the delay time, in seconds, after typing the control word, that will elapse before the transboundary blanking shutter is introduced into the optical path. Second parameter is the time, in seconds, that blanking shutter remains in the optical path.		M46, 10.0, 30.0, $	For this control word, the cloud cover will disappear 10 seconds after the control word is initialized and will reapper 30 seconds after it was removed from the scene.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
32	Sunrise Annuli	First parameter is the delay time in seconds, after typing the control word, that will elapse before the sunrise annuli is introduced into the optical path. Second parameter is the time, in seconds, that the sunrise annuli remains in the optical path.	Refer to Ref. No. 31A	M43, 10.0, 30.0, $	For this control word, the sunrise annuli will appear 10 seconds after the control word is initialized, and remain for 30 seconds before it is removed.
33A	Transboundary Illumination and Angenieux Varifocal lens, Turret No. I, Fast Rate	Pre-test setup	a. Reset yaw to 0 degrees and switch to automatic mode.		
			b. Manually set extended range off course so that only clouds are visible and leave in manual mode.		
			c. Manually set cloud film to test pattern.		
			d. Manually set transboundary Angenieux to maximum simulated altitude.		Center portion of cloud area should be lighted.
33B	Illumination Varifocal, Fast Rate	Activates the illumination varifocal lens at the fast rate (250,000 feet per second) to the maximum altitude scene (1000 NM).	Refer to Ref. No. 33A.	M35, 2500.0, 1000.0, $	Lighted area will increase until entire cloud cover is lighted. Elapsed time: approximately 30 seconds.
33C	Reset	Return to minimum.	No freeze stops.	F, 0.0	Lighted area will return to scene described in Ref. No. 33A.
34A	Angenieux Varifocal, Fast Rate	Pre-test setup.	a. Manually set transboundary Angenieux to minimum simulated altitude and place in automatic mode.		Note area of test pattern covered in FOV.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
34A (Cont)			b. Manually set transboundary illumination to maximum simulated altitude setting and leave in manual mode.		
34B		Activates the Angenieux Varifocal lens at the past rate (250,000 feet per second) to the maximum altitude scen (1000 NM).		M41, 2500.0, 1000.0, $	Area of test pattern covered in FOV should increase to approximately 4 times the original size. Elapsed time: approximately 30 seconds.
34C	Reset	Return to minimum.		F, 0.0	Area covered in FOV should return to original size (minimum simulated altitude).
35A	Transboundary Cassette, Angular Drive	Pre-test setup.	Manually set transboundary illumination and Angenieux lens to minimum simulated altitude and place in automatic mode.		
35B		Transboundary cassette is rotated at the maximum angular rate, 36 degrees per minute, to a plus 30 degree position.		M40, 36.0, 30.0, $	Test pattern will rotate approximately 30.0 degrees in 50 seconds.
35C		Transboundary cassette is rotated to the plus 90 degree position.	Change of freeze point only.	F, 90.0	Test pattern will rotate an additional 60 degrees in approximately 1 minute and 40 seconds.
35D		Transboundary cassette is rotated through the full angular range.	Change of freeze point only.	F, -90.0	Test pattern will rotate 180 degrees, from the plus 90 degree point to the minus 90 degree point, in approximately 2 minutes and 30 seconds.
35E	Reset	Return to zero degree position.		F, 0.0	Test pattern will rotate 90 degrees in the opposite direction and return to the original starting position (zero degrees).

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
36A	Transboundary Illumination and Angenieux varifocal lens, Turret No. I, Normal Rate	Activates the illumination and Angenieux varifocal lens simultaneoulsy at the normal rate.	Verify that both lens are in the minimum simulated altitude position.	M42, 2500.0, 200.0, M36, 2500.0, 0.0, $	a. Test pattern will decrease in size while FOV increases. b. Entire area will remain lighted. c. Elapsed time: approximately 4 minutes.
36B	Reset	Both lens are returned to the original position (minimum simulated altitude).		a. $	This symbol will clear the computer and cause "SELECT TESTS" to be printed at the output typewriter.
				b. M42, 2500.0, 100.0, M36, 2500.0, 0.0, $	Both lens are returned to the starting position.
37A	Transboundary Film, Forward	Moves cloud cover through optical path in the forward direction. First parameter is the rate of resolver movement in degrees per second. The second parameter is always 0.0.	a. No freeze stops. b. One orbit requires 1597.3 degrees of resolver movement.	M37, 8.834, 0.0, $	Film will advance 1 orbit in approximately three minutes and stop automatically.
37B	Transboundary Film, Reverse	Moves cloud cover through optical path in the reverse direction (refer to Ref. No. 37A).	Refer to Ref. No. 37A	M39, 8.834, 0.0, $	Film will complete 1 orbit in the reverse direction in approximately 3 minutes and stop automatically.
37C	Transboundary Film, Forward	Moves cloud cover through optical path in the forward direction. First parameter is the rate of resolver movement in degrees per second. The second parameter is always 0.0.	a. No freeze stops. b. One orbit requires 1597.3 degrees of resolver movement.	M37, 8.834, 0.0, $	Film will advance 1 orbit in approximately 3 minutes and stop automatically.
37D	Transboundary Film, Rapid Reset	Cloud film is indexed to starting point. Both parameters are always 0.0.	No freeze stops.	M38, 0.0, 0.0, $	Cloud film will move rapidly to starting position.
38A	Transboundary Horizon Mask Fast Rate	Pre-test Setup.	Set yaw servo to manual and adjust so that clouds and starfield are visible.		

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
38B	Forward	Moves transboundary horizon mask through the optical path at the fast rate (first parameter). Second parameter determines the altitude range (1424.0 NM maximum).		M44, 2500.0, 1424.0, $	Curvature of horizon will increase.
38C	Reset	Return horizon mask to starting position.	No freeze stops.	F, 0.0	Curvature of horizon will decrease until original position is reached.
39A	Transboundary Horizon Mask, Forward, Normal Rate	Moves transboundary horizon mask through the optical path at the normal rate (refer to 38).	Refer to Ref. No. 38A	M45, 2500.0, 300.0, $	Curvature of the horizon will increase slowly to 300 NM scene.
39B	Reset	Return horizon mask to the starting position.		a. $	This symbol will clear the computer and cause SELECT TESTS to be printed at the output typewriter.
				b. M45, 2500.0, 0.0, $	Curvature of the horizon will decrease slowly to minimum altitude scene.
39C	Manual Reset	Post-test manual reset	a. Set yaw to zero degrees. b. Ensure that extended range off course mirror is centered. c. Ensure that transboundary film drive is reset. d. Place in automatic mode.		Restore system to initial conditions.
40	C/M ATTITUDE Servo, Pitch	Combined scene will simulate pitch motion. First parameter is the rate of change in degrees per second. Second parameter is freeze point in angular degrees.	Servo pitch ratio is 1 to 1	M16, 40.0, 0.0, $	Combined scene will move vertically to the maximum upward view (plus 135 degrees), down through to the maximum downward view (minus 135 degrees), and return to the setting. Elapsed time: 13.5 seconds.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
41	C/M ATTITUDE Servo, Yaw	Combined scene will simulate yaw motion. (Refer to Ref. No. 40 for parameter data.)	Servo to yaw ratio is 1 to 1	M17, 40.0, 0.0, $	Combined scene will move horizontally to the maximum rightward view (plus 135 degrees), return through 0 to the maximum leftward view (minus 135 degrees), and return to 0 setting. Elapsed time: 13.5 seconds.
42A	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	Servo to roll ratio is 1 to 1	M18, 40.0, 90.0, $	Combined scene will rotate 90 degrees about its longitudinal axis. Elapsed time: approximately 2.25 seconds.
42B	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	Servo to roll ratio is 1 to 1	F, 180.0	Scene will rotate an additional 90 degrees.
42C	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	Servo to roll ratio is 1 to 1	F, 90.0	Scene will rotate 90 degrees in the opposite direction.
42D	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	Servo to roll ratio is 1 to 1	F, -90.0	Scene will rotate an additional 180 degrees.
42E	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	Servo to roll ratio is 1 to 1	F, -180.0	Scene will rotate an additional 90 degrees.
42F	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	Servo to roll ratio is 1 to 1	F, -90	Scene will rotate to the plus 90 degree position.
42G	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	Servo to roll ratio is 1 to 1	F, 0.0	Scene will return to original attitude.
42H	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).	No freeze stops.	M18, 40.0, 0.0, $	Entire scene will rotate to the plus 180 degree point, reverse direction and make 1 complete revolution (minus 360 degrees), reverse direction again and return to the starting point. Elapsed time: 9 seconds NOTE Error voltage should not build up excessively.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
42I	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).		M18, 0.1, 10.0, $	Entire scene will rotate smoothly to the plus 10 degree position in 40 seconds.
42J	C/M ATTITUDE Servo, Roll	Combined scene will simulate roll motion (refer to Ref. No. 40 for parameter data).		a. $	Clears computer and causes SELECT TESTS to be printed at the output typewriter.
				b. M18, 40.0, 0.0, $	Scene will return to 0 attitude position.
43A	Solar Iris and Blanking	Pre-test setup	a. Manually switch in the earth and trans-boundary shutters. b. Manually switch out the solar blanking shutter and switch to automatic mode.		Solar image will appear centered on four window MEP's only.
43B	Solar Iris Diaphram	First parameter is the delay time, in seconds, after typing the control word, that will elapse before the iris diaphram begins to close. Second parameter is the time, in seconds, that the iris diaphram remains closed.		M49, 10.0, 30.0, $	For this control word, the solar image will begin to dim 10 seconds after the control word is initialized, stay dim for 30 seconds, then return to original brightness.
43C	Solar Blanking	Controls the solar blanking shutter. Control word parameter perform the function as described for the iris diaphram. (Refer to Ref. No. 43B.)		M50, 10.0, 30.0, $	For this control word, the solar image will be occulted 10 seconds after the control word is initialized, remain occulted for 30 seconds, then return to view.
44A	Solar Yaw and Focus, Fast Rate	Solar image is traversed through full range of simulated yaw attitude. First parameter is rate of yaw motion in degrees per second. Second parameter freeze point in angular degrees.	Refer to Ref. No. 43A	M47, 40.0, 0.0, $	a. Solar image will move horizontally to the extreme left side, change direction and move to the extreme right side, then return to the center position. b. Image should remain in focus throughout the test. c. Servos should follow at fast rate without excessive error. d. Elapsed time: 5.5 seconds.

Table 2-63. Mission Effect Projector Computer Test (Cont)

Ref. No.	Test Title	Test Description	Test Conditions	Control Word	Results
44B	Solar Yaw and Focus, Slow Rate	Solar image is traversed at a slow rate. (Refer to Ref. No. 44A for parameter data.)		M47, 1.0, 55.0, $	Solar image will move to extreme right side (55 degrees) in approximately 55 seconds.
44C	Reset	Return to initial position.		a. $	Clears computer and causes SELECT TESTS to be printed at the output typewriter.
				b. M47, 40.0, 0.0, $	Solar image will return to the center position.
45A	Solar Pitch and Focus, Fast Rate	Solar image is traversed through the full range of simulated pitch attitude. First parameter is rate of pitch attitude in degrees per second. Second parameter is freeze point in angular degrees.	Refer to Ref. No. 43A	M48, 40.0, 0.0, $	a. Solar image will move vertically to the top of the view, change direction and move to the bottom, then return to the center position. b. Image should remain in focus throughout the test. c. Servos should follow at the fast rate without excessive error. d. Elapsed time: 5.5 seconds.
45B	Solar Pitch, Slow Rate	Solar image is traversed at a slow rate. (Refer to Ref. No. 45A for parameter data.)		M48, 1.0, 55.0, $	Solar image will move to the top of the view in approximately 55 seconds.
45C	Reset	Return to initial position.		a. $	Clears computer and causes SELECT TESTS to be printed at the output typewriter.
				b. M48, 40.0, 0.0, $	Solar image will return to the center of the screen.
46	Solar Pitch and Yaw	Solar image is traversed simulating pitch and yaw motion simultaneously.	Refer to Ref. No. 43A	M47, 1.0, 0.0, M48, 1.0, 0.0, $	Solar image will move at an angle of 45 degrees to the top of the scene, then return to the center. Elapsed time: 3 minutes and 40 seconds.

Table 2-64. MEP Computer Test Parameters

		Diagnostic Control Word Message Symbol Inputs									
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
M	2	1.0 or 0.0	1.0 or 0.0		0.0		0.0		DBO245	V491	Quick Dissolve Enabling - Landing Window #1
									DBO248	V494	Quick Dissolve Enabling - Landing Window #5
									DBO246	V492	Quick Dissolve Enabling - Rendezvous Window #2
									DBO247	V493	Quick Dissolve Enabling - Rendezvous Window #4
									DBO249	V495	Quick Dissolve Enabling - Telescope
									DBO240	V401	Quick Dissolve Enabling Execution (To Turret II) - Landing Window #1
									DBO243	V404	Quick Dissolve Enabling Execution (To Turret II) - Landing Window #5
									DBO241	V402	Quick Dissolve Enabling Execution (To Turret II) - Rendezvous Window #2
									DBO242	V403	Quick Dissolve Enabling Execution (To Turret II) - Rendezvous Window #4
									DBO244	V405	Quick Dissolve Enabling Execution (To Turret II) - Telescope
M	3	125.0	2500.0	Ft/Sec	100.0	215.4	100.0	NM	D/A400	VEEEMV11	E/M Illumination Varifocal Turret I - Landing Window #1
									D/A403	VEEEMV41	E/M Illumination Varifocal Turret I - Landing Window #5
									D/A401	VEEEMV21	E/M Illumination Varifocal Turret I - Rendezvous Window #2
									D/A402	VEEMV31	E/M Illumination Varifocal Turret I - Rendezvous Window #4
									D/A404	VEEMV51	E/M Illumination Varifocal Turret I - Telescope

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs											
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		FAST				FAST/NORMAL			DBO250	V411	Boolean - Fast Rate (All MEP's)
M	4	NORMAL				FAST/NORMAL			DBO251	V412	Boolean - Return to Normal Rate (All MEP's)
M	5	125.0	2500.0	Ft/Sec	100.0	215.4	100.0	NM	D/A405	VEEEMV12	E/M Illumination Varifocal Turret II - Landing Window #1
									D/A408	VEEEMV42	E/M Illumination Varifocal Turret II - Landing Window #5
									D/A406	VEEEMV22	E/M Illumination Varifocal Turret II - Rendezvous Window #2
									D/A407	VEEEMV32	E/M Illumination Varifocal Turret II - Rendezvous Window #4
									D/A409	VEEEMV52	E/M Illumination Varifocal Turret II - Telescope
		FAST				FAST/NORMAL			DBO252	V413	Boolean - Fast Rate (All MEP's)
		NORMAL				FAST/NORMAL			DBO253	V414	Boolean - Return to Normal Rate (All MEP's)
M	7	125.0	2500.0	Ft/Sec	100.0	215.4	100.0	NM	D/A410	VEEOFA11	Vertical Rate (Angenieux) Turret I - Landing Window #1
									D/A413	VEEOFA41	Vertical Range (Angenieux) Turret I - Landing Window #5
									D/A411	VEEOFA21	Vertical Range (Angenieux) Turret I - Rendezvous Window #2
									D/A412	VEEOFA31	Vertical Range (Angenieux) Turret I - Rendezvous Window #4
									D/A414	VEEOFA51	Vertical Range (Angenieux) Turret I - Telescope

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs											
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		FAST				DELAY 30 SEC			DBO254	V512	Boolean - Fast Rate (All MEP's)
M	8	NORMAL							DBO255	V513	Boolean - Return to Normal Rate (All MEP's)
M	9	125.0	2500.0	Ft/Sec	100.0	215.4	100.0	NM	D/A415	VEEOFA12	Vertical Range (Angenieux) Turret II - Landing Window #1
									D/A418	VEEOFA42	Vertical Range (Angenieux) Turret II - Landing Window #5
									D/A416	VEEOFA22	Vertical Range (Angenieux) Turret II - Rendezvous Window #2
									D/A417	VEEOFA32	Vertical Range (Angenieux) Turret II - Rendezvous Window #4
									D/A419	VEEOFA52	Vertical Range (Angenieux) Turret II - Telescope
		FAST				DELAY 30 SEC			DBO256	V514	Boolean - Fast Rate (All MEP's)
M	10	NORMAL							DBO257	V515	Boolean - Return to Normal Rate (All MEP's)
M	11	0.005	0.838	MM/Sec	0.0 to 27.94 to 0.0 to -27.94 to 0.0			MM	D/A425	VEEER1	Extended range off-course - Landing Window #1
									D/A428	VEEER4	Extended range off-course - Landing Window #5
									D/A426	VEEER2	Extended range off-course - Rendezvous Window #2
									D/A427	VEEER3	Extended range off-course - Rendezvous Window #4
									D/A429	VEEER5	Extended range off-course - Telescope
		FAST							DBO258	V511	Boolean - Fast Rate (All MEP's)

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs

Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Inital Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
M	12	NORMAL							DBO258	V511	Extended range off-course (Normal Rate)
				NOTE: Test M12 should also actuate D/A430 thru D/A434							
M	13	0.4	6.1	MM/Sec	0.0 to 50.0126 to 0.0 to -50.0126 to 0.0			MM	D/A430	VEEDNT1	Day-Night Terminator Time Drive - Landing Window #1
									D/A433	VEEDNT4	Day-Night Terminator Time Drive - Landing Window #5
									D/A431	VEEDNT2	Day-Night Terminator Time Drive - Rendezvous Window #2
									D/A432	VEEDNT3	Day-Night Terminator Time Drive - Rendezvous Window #4
									D/A434	VEEDNT5	Day-Night Terminator Time Drive - Telescope
		FAST							DBO259	V516	Boolean - Fast Rate (All MEP's)
		NORMAL							DBO260	V517	Boolean - Return to Normal Rate (AllMEP's)
M	15	0.5	0.5	DEG/Sec	0.0 to 90.0 to 0.0 to -90.0 to 0.0				D/A435	VEEDNA1	Day-Night Terminator Angular Drive - Landing Window #1
									D/A438	VEEDNA4	Day-Night Terminator Angular Drive - Landing Window #1
									D/A436	VEEDNA2	Day-Night Terminator Angular Drive - Rendezvous Window #2
									D/A437	VEEDNA3	Day-Night Terminator Angular Drive - Rendezvous Window #4
									D/A439	VEEDNA5	Day-Night Terminator Angular Drive - Telescope

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs											
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
M	16	0.04	40.0	Deg/Sec	0.0 to 135.0	to 0.0 to -135.0	to 0.0		D/A370	VESTHSC1	C/M Pitch Servo-Coarse-Landing Window #1
									D/A371	VECTHSC1	
									D/A388	VESTHSC4	C/M Pitch Servo-Coarse-Landing Window #5
									D/A389	VECTHSC4	
									D/A376	VESTHSC2	C/M Pitch Servo-Coarse - Rendezvous Window #2
									D/A377	VECTHSC2	
									D/A382	VESTHSC3	C/M Pitch Servo-Coarse - Rendezvous Window #4
									D/A383	VECTHSC3	
									D/A394	VESTHSC5	C/M Pitch Servo - Telescope
									D/A395	VECTHSC5	
									D/A492	VESTHSF1	C/M Pitch Servo-Fine - Landing Window #1
									D/A493	VECTHSF1	
									D/A498	VESTHSF4	C/M Pitch Servo-Fine - Landing Window #5
									D/A499	VECTHSF4	
									D/A494	VESTHSF2	C/M Pitch Servo-Fine - Rendezvous Window #2
									D/A495	VECTHSF2	C/M Pitch Servo-Fine - Rendezvous Window #2
									D/A498	VESTHSF3	C/M Pitch Servo-Fine - Rendezvous Window #4
									D/A499	VECTHSF3	
									DWOD	VETHSF5	C/M Pitch Servo-Fine - Telescope
M	17	0.04	40.0	Deg/Sec	0.0 to 135.0	to 0.0 to 135.0	to 0.0		D/A372	VESPSSC1	C/M Yaw Servo-Coarse - Landing Window #1
									D/A373	VECPSSC1	
									D/A390	VESPSSC4	C/M Yaw Servo-Coarse - Landing Window #5
									D/A391	VECPSSC4	
									D/A378	VESPSSC2	C/M Yaw Servo-Coarse - Rendezvous Window #2

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs											
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
									D/A379	VECPSSC2	
									D/A384	VESPSSC3	C/M Yaw Servo-Coarse - Rendezvous Window #4
									D/A385	VECPSSC3	
									D/A396	VESPSSC5	C/M Yaw Servo-Coarse - Telescope
									D/A397	VECPSSC5	
									D/A502	VESPSSF1	C/M Yaw Servo-Fine - Landing Window #1
									D/A503	VECPSSF1	
									D/A508	VESPSSF4	C/M Yaw Servo-Fine - Landing Window #5
									D/A509	VECPSSF4	
									D/A504	VESPSSF2	C/M Yaw Servo-Fine - Rendezvous Window #2
									D/A505	VECPSSF2	
									D/A506	VESPSSF3	C/M Yaw Servo-Fine - Rendezvous Window #4
									D/A507	VECPSSF3	
									DWOD27	VECPSSF3	C/M Yaw Servo-Fine - Telescope
M	18	0.04	40.0	Deg/Sec	0.0 to 135.0 to 0.0 to 135.0 to 0.0				D/A374	VESPHSC1	C/M Attitude Roll Servo-Coarse - Landing Window #1
									D/A375	VECPHSC1	
									D/A392	VESPHSC4	C/M Attitude Roll Servo-Coarse - Landing Window #5
									D/A393	VECPHSC4	
									D/A380	VESPHSC2	C/M Attitude Roll Servo-Coarse - Rendezvous Window #2
									D/A381	VECPHSC2	
									D/A386	VESPHSC3	C/M Attitude Roll Servo-Coarse - Rendezvous Window #4
									D/A387	VECPHSC3	
									D/A398	VESPHSC5	C/M Attitude Roll Servo-Coarse - Telescope

Table 2-64. MEP Computer Test Parameters (Cont)

Test		Diagnostic Control Word Message Symbol Inputs									
		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Device	Channel Description
									D/A399	VECPHSC5	
									D/A512	VESPHSF1	C/M Attitude Roll Servo - Fine - Landing Window #1
									D/A513	VECPHSF1	
									D/A518	VESPHSF4	C/M Attitude Roll Servo - Fine - Landing Window #5
									D/A519	VECPHSF4	
									D/A514	VESPHSF2	C/M Attitude Roll Servo - Fine - Rendezvous Window #2
									D/A515	VECPHSF2	
									D/A516	VESPHSF3	C/M Attitude Roll Servo - Fine - Rendezvous Window #4
									D/A517	VECPHSF3	
									DWOD28	VEPHSF5	C/M Attitude Roll Servo - Fine - Telescope
M	19	0.0	200.0	Sec.	0.0		200.0	Sec.	DBO261	V519	Earth Blanking Shutter and E/M Ill. - Landing Window #1
									DBO264	V549	Earth Blanking Shutter and E/M Ill. - Landing Window #5
									DBO262	V529	Earth Blanking Shutter and E/M Ill. - Rendezvous Window #2
									DBO263	V439	Earth Blanking Shutter and E/M Ill. - Rendezvous Window #4
									DBO265	V559	Earth Blanking Shutter and E/M Ill. - Telescope
M	20	1.930	307.020	NM/min	0.0 to 737.491 to 0.0 to -737.491 to 0.0				D/A440	VEEOC11	Orbital Film Off Course - Turret I - Landing Window #1
									D/A443	VEEOC41	Orbital Film Off Course - Turret I - Landing Window #5
									D/A441	VEEOC21	Orbital Film Off Coarse - Turret I - Rendezvous Window #2

Table 2-64. MEP Computer Test Parameters (Cont)

Test		Diagnostic Control Word Message Symbol Inputs									
		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
									D/A442	VEEOC31	Orbital Film Off-Course - Turret II - Rendezvous Window #4
									D/A444	VEEOC51	Orbital Film Off-Course - Turret II - Telescope
M	21	1.930	307.020	MM/min	0.0 to 737.491 to 0.0 to -737.491 to 0.0				D/A445	VEEOC12	Orbital Film Off-Course - Turret II - Landing Window #1
									D/A448	VEEOC42	Orbital Film Off-Course - Turret II - Landing Window #5
									D/A446	VEEOC22	Orbital Film Off-Course - Turret II - Rendezvous Window #2
									D/A447	VEEOC32	Orbital Film Off-Course - Turret II - Rendezvous Window #4
									D/A449	VEEOC52	Orbital Film Off-Course - Turret II - Telescope
M	22	0.980	14.71	Deg/Sec		0.0			DWOD4	VETHO11A	Orbital Film Drive - Turret IIa - Landing Window #1
									DWOD7	VETHO41A	Orbital Film Drive - Turret IIa - Landing Window #5
									DWOD5	VETHO21A	Orbital Film Drive - Turret IIa - Rendezvous Window #2
									DWOD6	VETHO31A	Orbital Film Drive - Turret IIa - Rendezvous Window #4
									DWOD8	VETHO51A	Orbital Film Drive - Turret IIa - Telescope
M	23	0.980	14.71	Deg/Sec		0.0			DWOD9	VETHO12A	Orbital Film Drive - Turret IIc - Landing Window #1
									DWOD12	VETHO42A	Orbital Film Drive - Turret IIc - Landing Window #5

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs

Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
									DWOD10	VETHO22A	Orbital Film Drive - Turret IIc - Rendezvous Window #2
									DWOD11	VETHO32A	Orbital Film Drive - Turret IIc - Rendezvous Window #5
									DWOD13	VETHO52A	Orbital Film Drive - Turret IIc - Telescope
		FAST FAST							DBO268	V615	Boolean - Fast Rate (All MEP's) Turret IIa
									DBO269	V616	Boolean - Fast Rate (All MEP's) Turret IIc
M	24	0.980	14.71	Deg/sec		0.0			DBO270	V617	Boolean - Return to Normal Rate (All MEP's) Turret IIa
M	25	0.980	14.71	Deg/sec		0.0			DBO296	V618	Boolean - Return to Normal Rate (All MEP's) Turret IIc
M	26	0.0				0.0			DBO266	V613	Boolean - Fast Reset to Zero (All MEP's) Turret IIa
M	27	0 0				0.0			DBO267	V614	Boolean - Fast Reset to Zero (AllMEP's) Turret IIc
M	28	10.0	25.0	Deg/Sec		0.0			DBO297	V771	Boolean - Reverse Direction (All MEP's) Turret IIa
M	29	10.0	25.0	Deg/Sec		0.0			DBO298	V781	Boolean - Reverse Direction (All MEP's) Turret IIc
M	30	0.0	64.8	Deg/Sec		0.0			DWOD15	VEETM12	Trans-Earth/Lunar Film Drive - Turret Ic - Landing Window #1
									DWOD18	VEETM42	Trans-Earth/Lunar Film Drive - Turret Ic - Landing Window #5
									DWOD16	VEETM22	Trans-Earth/Lunar Film Drive - Turret Ic - Rendezvous Window #2

Table 2-64. MEP Computer Test Parameters (Cont)

		Diagnostic Control Word Message Symbol Inputs									
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
									DWOD17	VEETM32	Trans-Earth/Lunar Film Drive - Turret Ic - Rendezvous Window #4
									DWOD19	VEETEM52	Trans-Earth/Lunar Film Drive - Turret Ic - Telescope
M	31		0.0			0.0			DBO271	V712	Boolean - Fast Zero Reset (All MEP's)
											Turret Indexing & Air Valve Solenoid Turret I
M	32	1.0	0.0			0.0			DBO245	V491	Quick Dissolve Enabling - Landing Window #1
									DBO248	V494	Quick Dissolve Enabling - Landing Window #5
									DBO246	V492	Quick Dissolve Enabling - Rendezvous Window #2
									DBO247	V493	Quick Dissolve Enabling - Rendezvous Window #4
									DBO249	V495	Quick Dissolve Enabling - Telescope
									DBO240	V401	Quick Dissolve Actuation - Landing Window #1
									DBO243	V404	Quick Dissolve Actuation - Landing Window #5
									DBO241	V402	Quick Dissolve Actuation - Rendezvous Window #2
									DBO242	V403	Quick Dissolve Actuation - Rendezvous Window #4
									DBO244	V405	Quick Dissolve Actuation - Telescope
									DBO272	V713	Cassette Preselection - Turret I (All MEP's)
									DBO273	V714	CassettePreselection - Turret I (All MEP's)
									DBO276	V611	Actuation Turret I (All MEP's)
									DBO245	V491	Quick Dissolve Enabling - Landing Window #1
									DBO248	V494	Quick Dissolve Enabling - Landing Window #5

Table 2-64. MEP Computer Test Parameters (Cont)

		Diagnostic Control Word Message Symbol Inputs									
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
									DBO246	V492	Quick Dissolve Enabling - Rendezvous Window #2
									DBO247	V493	Quick Dissolve Enabling - Rendezvous Window #4
									DBO249	V495	Quick Dissolve Enabling - Telescope
									DBO240	V401	Quick Dissolve Actuation - Landing Window #1
									DBO243	V404	Quick Dissolve Actuation - Landing Window #5
									DBO241	V402	Quick Dissolve Actuation - Rendezvous Window #2
									DBO242	V403	Quick Dissolve Actuation - Rendezvous Window #4
									DBO244	V405	Quick Dissolve Actuation - Telescope
											Turret Indexing & Air Valve Solenoid - Turret II
M	33	1.0	0.0		0.0				DBO245	V491	Quick Dissolve Enabling - Landing Window #1
									DBO248	V494	Quick Dissolve Enabling - Landing Window #5
									DBO246	V492	Quick Dissolve Enabling - Rendezvous Window #2
									DBO247	V493	Quick Dissolve Enabling - Rendezvous Window #4
									DBO249	V495	Quick Dissolve Enabling - Telescope
									DBO240	V401	Quick Dissolve Actuation - Landing Window #1
									DBO243	V404	Quick Dissolve Actuation - Landing Window #5
									DBO241	V402	Quick Dissolve Actuation - Rendezvous Window #2
									DBO242	V403	Quick Dissolve Actuation - Rendezvous Window #4
									DBO244	V405	Quick Dissolve Actuation - Telescope
									DBO274	V715	Cassette Preselection - Turret II (All MEP's)

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
									DBO275	V716	Cassette Preselection - Turret II (All MEP's)
									DBO277	V612	Actuation Turret II (All MEP's)
									DBO245	V491	Quick Dissolve Enabling - Landing Window #1
									DBO248	V494	Quick Dissolve Enabling - Landing Window #5
									DBO246	V492	Quick Dissolve Enabling - Rendezvous Window #2
									DBO247	V493	Quick Dissolve Enabling - Rendezvous Window #4
									DBO249	V495	Quick Dissolve Enabling - Telescope
									DBO240	V401	Quick Dissolve Actuation - Landing Window #1
									DBO243	V402	Quick Dissolve Actuation - Landing Window #5
									DBO241	V402	Quick Dissolve Enabling - Rendezvous Window #2
									DBO242	V403	Quick Dissolve Enabling - Rendezvous Window #5
									DBO244	V405	Quick Dissolve Enabling - Telescope
M	34	0.0	200.0		0.0		200.0		DBO278	V717	Spherical Distortion Lens (Both Turrets - All MEP's)
M	35	125.0	2500.0		100.0	1000.0	100.0	NM	D/A450	VEETV1	Illum. Varif. Drive (Transboundary) - Landing Window #1
									D/A453	VEETV4	Illum. Varif. Drive (Transboundary) - Landing Window #5
									D/A451	VEETV2	Illum. Varif. Drive (Transboundary) - Rendezvous Window #2
									D/A452	VEETV3	Illum. Varif. Drive (Transboundary) - Rendezvous Window #4
									D/A454	VEETV5	Illum. Varif. Drive (Transboundary) - Telescope
									DBO279	V810	Boolean Fast Rate (All MEP's)

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs											
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
M	36	125.0	2500.0		100.0	1000.0	100.0	NM	DBO280	V811	Boolean Return to Normal Rate (All MEP's)
M	37	0.589	8.834	Deg/sec		0.0			D/A455	VESTHP1	Transboundary Cassette Film Drive - Landing Window #1
									D/A456	VECTHP1	
									D/A461	VESTHP4	Transboundary Cassette Film Drive - Landing Window #5
									D/A462	VECTHP4	
									D/A457	VESTHP2	Transboundary Cassette Film Drive - Rendezvous Window #2
									D/A458	VECTHP2	
									D/A459	VESTHP3	Transboundary Cassette Film Drive - Rendezvous Window #4
									D/A460	VECTHP3	
									D/A463	VESTHP5	Transboundary Cassette Film Drive - Telescope
									D/A464	VECTHP5	
M	39	0.0				0.0			DBO281	V812	Boolean-Rapid Zero Reset (All MEP's)
M	39	0.589	8.834	Deg/sec		0.0					Same as M37
M	40	0.0	36.0	Deg/Min	0.0 to 90.0 to 0.0 to -90.0 to 0.0			Deg	D/A465	VEEPAA1	Transboundary Cassette Angular Drive - Landing Window #1
									D/A468	VEEPAA4	Transboundary Cassette Angular Drive - Landing Window #5
									D/A466	VEEPAA2	Transboundary Cassette Angular Drive - Rendezvous Window #2
									D/A467	VEEPAA3	Transboundary Cassette Angular Drive - Rendezvous Window #4
									D/A469	VEEPAA5	Transboundary Cassette Angular Drive - Telescope

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs

Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
M	41	125.0	2500.0	Ft/sec	100.0	1000.0	100.0	NM	D/A470	VEETAL1	Transboundary Vertical Range Angenieux Varif. - Landing Window #1
									D/A473	VEETAL4	Transboundary Vertical Range Angenieux Varif. - Landing Window #5
									D/A471	VEETAL2	Transboundary Vertical Range Angenieux Varif. - Rendezvous Window #2
									D/A472	VEETAL3	Transboundary Vertical Range Angenieux Varif. - Rendezvous Window #4
									D/A474	VEETAL5	Transboundary Vertical Range Angenieux Varif. - Telescope
									DBO283	V815	Boolean Fast Rate (All MEP's)
M	42	125.0	2500.0	Ft/sec	100.0	1000.0	100.0	NM	DBO284	V816	Boolean - Return to Normal Rate (All MEP's)
M	43	0.0	200.0	Sec.	0.0		200.0	Sec	DBO285	V817	Sunrise Annuli (All MEP's)
M	44	125.0	2500.0	Ft/sec	100.0	1424.0	100.0	NM	D/A475	VEEHMV1	Transboundary Horizon Mask Varifocal - Landing Window #1
									D/A478	VEEHMV4	Transboundary Horizon Mask Varifocal - Landing Window #5
									D/A476	VEEHMV2	Transboundary Horizon Mask Varifocal - Rendezvous Window #2
									D/A477	VEEHMV3	Transboundary Horizon Mask Varifocal - Rendezvous Window #4
									D/A479	VEEMV5	Transboundary Horizon Mask Varifocal - Telescope
									DBO286	V818	Boolean Fast Rate (All MEP's)
M	45	125.0	2500.0	Ft/sec	100.0	1424.0	100.0	NM	DBO287	V819	Boolean-Return to Normal Rate (All MEP's)

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs											
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
M	46	0.0	200.0	Deg/sec	0.0		200.0	Sec.	DBO288	V910	Transboundary Scene Blanking Shutter &Transboundary Lamp Half Power - Landing Window #1
									DBO291	V940	Transboundary Scene Blanking Shutter & Transboundary Lamp Half Power - Landing Window #5
									DBO289	V920	Transboundary Scene Blanking Shutter & Transboundary Lamp Half Power - Rendezvous Window #2
									DBO290	V930	Transboundary Scene Blanking Shutter & Transboundary Lamp Half Power - Rendezvous Window #4
									DBO292	V950	Transboundary Scene Blanking Shutter & Transboundary Lamp Half Power - Telescope
M	47	0.4	40.0	Deg/sec	0.0 to 55.0 to 0.0 to -55.0 to 0.0			Deg.	D/A484	VEEALPS1	Solar Scan-Yaw Drive - Landing Window #1
									D/A487	VEEALPS4	Solar Scan-Yaw Drive - Landing Window #5
									D/A485	VEEALPS2	Solar Scan-Yaw Drive - Rendezvous Window #2
									D/A486	VEEALPS3	Solar Scan-Yaw Drive - Rendezvous Window #4
M	48	0.4	40.0	Deg/sec	0.0 to 55.0 to 0.0 to -55.0 to 0.0			Deg.	D/A488	VEEBLPS1	Solar Scan-Pitch Drive - Landing Window #1
									D/A491	VEEBLPS4	Solar Scan-Pitch Drive - Landing Window #5
									D/A489	VEEBLPS2	Solar Scan-Pitch Drive - Rendezvous Window #2

Table 2-64. MEP Computer Test Parameters (Cont)

Diagnostic Control Word Message Symbol Inputs											
Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
									D/A490	VEEBLPS3	Solar Scan-Pitch Drive - Rendezvous Window #4
M	49	0.0	200.0	Sec.	0.0		200.0	Sec.	DBO311	V791	Solar Iris - Drive - Landing Window #1
									DBO314	V794	Solar Iris - Drive - Landing Window #5
									DBO312	V792	Solar Iris - Drive - Rendezvous Window #2
									DBO313	V793	Solar Iris - Drive - Rendezvous Window #4
M	50	0.0	200.0	Sec.	0.0		200.0	Sec.	DBO300	V211	Solar Blanking Shutter & Solar Lamp Half Power - Landing Window #1
									DBO301	V241	Solar Blanking Shutter & Solar Lamp Half Power - Landing Window #5
									DBO302	V221	Solar Blanking Shutter & Solar Lamp Half Power - Rendezvous Window #2
									DBO303	V231	Solar Blanking Shutter & Solar Lamp Half Power - Rendezvous Window #4

Table 2-65. Rendezvous Servo System, Computer Test

			DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
	RENDEZVOUS SERVO SYSTEM		Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
1	INITIALIZATION OF RENDEZVOUS SERVO SYSTEM	All device channels associated with the rendezvous servo system are set to their initial positions. (Tests R2, R3, R4, R8 to R16.)	R	1	0.0			0.0						All device channels associated with the rendezvous servo system (test R2 to R16).
2	RENDEZVOUS CAMERA POSITION SERVO DRIVE (IN)	The rendezvous camera position servo drive (IN) drives the camera from 87.5 to 0.5 inches. The rate of motion may vary between 0.06 and 6.0 inches/second. A programmable stop (freeze point) may be entered between 87.5 and 0.5 inches. For additional freeze point entry, refer to paragraph 2-35.	R	2	0.06	6.0	in/sec	87.5		0.5	in.	D/AF 003	VCEXCP	Rdv camera position servo drive
3	RENDEZVOUS CAMERA FOCUS SERVO DRIVE (IN)	The rendezvous camera focus servo drive (IN) drives the camera focus in such a manner as to maintain camera focus as the camera to model distance change. In effect, the distance the focus is driven is a function of the distance the camera moves. Thus, the focus is said to be driven from 87.5 to 0.5 inches. The rate of motion may vary between 0.06 and 6.0 inches/second. A programmable stop (freeze point) may be entered between 87.5 and 0.5 inches. For additional freeze point entry, refer to paragraph 2-35.	R	3	0.06	6.0	in/sec	87.5		0.5	in.	D/A 355	VCEFD	Rdv camera focus servo drive
4	RENDEZVOUS CRT TRANSLATIONAL SERVO DRIVE (IN)	The rendezvous CRT translational servo drive will drive from 0.1 to 5.0 inches to effect perspective. The rate of motion may vary between 0.01 to 1.0 inches/second. A programmable stop may be entered between 0.1 and 5.0 inches. For additional freeze point entry, refer to paragraph 2-35.	R	4	0.01	1.0	in/sec	0.1		5.0	in.	D/A 356 D/A 357	VCEDCRT2 VCEDCRT3	Rdv CRT translational servo drive, rdv window No. 2 Rdv CRT translational servo drive, rdv window No. 4
5	RENDEZVOUS CAMERA POSITION SERVO DRIVE (OUT)	The rendezvous camera position servo drive (OUT) drives the camera from 0.5 to 87.5 inches. The rate of motion may vary between 0.06 and 6.0 inches/second. A programmable stop (freeze point) may be entered between 0.5 and 87.5 inches. For additional freeze point entry, refer to paragraph 2-35.	R	5	0.06	6.0	in/sec	0.5		87.5	in.	Same as results of test R2		

Table 2-65. Rendezvous Servo System, Computer Test (Cont)

	RENDEZVOUS SERVO SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
6	RENDEZVOUS CAMERA FOCUS SERVO DRIVE (OUT)	The rendezvous camera focus servo drive (OUT) drives the camera focus in such a manner as to maintain camera focus as the camera to model distance changes. In effect, the distance the focus is driven is a function of the distance the camera moves. Thus, the focus is said to be driven from 0.5 to 87.5 inches. The rate of motion may vary between 0.06 and 6.0 inches/second. A programmable stop (freeze point) may be entered between 0.5 and 87.5 inches. For additional freeze point entry, refer to paragraph 2-35.	R	6	0.06	6.0	in/sec	0.5		87.5	in.	Same as results of test R3		
7	RENDEZVOUS CRT TRANSLATIONAL SERVO DRIVE (OUT)	The rendezvous CRT translational servo drive will drive from 5.0 to 0.1 inches to effect perspective. The rate of motion may vary between 0.01 to 1.0 inches/second. A programmable stop may be entered between 5.0 and 0.1 inches. For additional freeze point entry, refer to paragraph 2-35.	R	7	0.01	1.0	in/sec	5.0		0.1	in.	Same as results of test R4		
8	RENDEZVOUS VIDICON ALPHA (α) SERVO DRIVE (POSITIVE)	The rendezvous vidicon alpha servo drive (positive) will traverse from 0.0 to 6.0 degrees and back to 0.0 degrees. The rate of rotation may vary from 0.06 to 6.0 degrees/second. A programmable stop may be entered between 0.0 and +6.0 degrees. For additional freeze point entry, refer to paragraph 2-35.	R	8	0.06	6.0	deg/sec	0.0	6.0	0.0	deg	D/AF 001	VCEALPC	Rdv vidicon alpha servo drive
9	RENDEZVOUS VIDICON ALPHA (α) SERVO DRIVE (NEGATIVE)	The rendezvous vidicon alpha servo drive (negative) will traverse from 0.0 to -6.0 degrees and back to 0.0 degrees. The rate of rotation may vary from 0.06 to 6.0 degrees/second. A programmable stop may be entered between 0.0 and -6.0 degrees. For additional freeze point entry, refer to paragraph 2-35.	R	9	0.06	6.0	deg/sec	0.0	-6.0	0.0	deg	Same as results of test R8		

Table 2-65. Rendezvous Servo System, Computer Test (Cont)

			DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
RENDEZVOUS SERVO SYSTEM			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
10	RENDEZVOUS VIDICON BETA (β) SERVO DRIVE (POSITIVE)	The rendezvous vidicon beta servo drive (positive) will traverse from 0.0 to +6.0 degrees and back to 0.0 degrees. The rate of rotation may vary from 0.06 to 6.0 degrees/second. A programmable stop may be entered between 0.0 and +6.0 degrees. For additional freeze point entry, refer to paragraph 2-35.	R	10	0.06	6.0	deg/sec	0.0	6.0	0.0	deg	D/AF 002	VCEBEPC	RVD vidicon beta servo drive
11	RENDEZVOUS VIDICON BETA (β) SERVO DRIVE (NEGATIVE)	The rendezvous vidicon beta servo drive (negative) will traverse from 0.0 to -6.0 degrees and back to 0.0 degrees. The rate of rotation may vary from 0.06 to 6.0 degrees/second. A programmable stop may be entered between 0.0 and -6.0 degrees. For additional freeze point entry, refer to paragraph 2-35.	R	11	0.06	6.0	deg/sec	0.0	-6.0	0.0	deg	Same as results of test R10		
12	RENDEZVOUS MODEL XI (ξ) SERVO DRIVE	The rendezvous model XI (ξ) servo drive will traverse from +110.0 to +80.0 degrees, back through +110.0 degrees. The rate of rotation may vary from 0.03 to 10.0 degrees/second. A programmable stop (freeze point) may be entered between +80.0 and +140.0 degrees. Whenever an entered programmable stop is algebraically less than the previous amount entered, the servo will first drive to the end point and stop on the reverse swing. For additional freeze point entry, refer to paragraph 2-35.	R	12	0.03	10.0	deg/sec	110.0	110.0	110.0	deg	D/A 365 D/A 366	VCETHT1 VCETHT2	Rdv model XI (ξ) servo drive, sine Rdv model XI (ξ) servo drive, cosine
13	RENDEZVOUS MODEL ETA (η) SERVO DRIVE	The rendezvous model eta (η) servo drive will rotate from 0.0 to 360.0 degrees. The rate of rotation may vary from 0.03 to 10.0 degrees/second. A programmable stop (freeze point) may be entered between 0.0 and 360.0 degrees. For additional freeze point entry, refer to paragraph 2-35.	R	13	0.03	10.0	deg/sec	0.0		360.0	deg	D/A 369 D/A 354	VCEPHT1 VCEPHT2	Rdv, model eta (η) servo drive, sine Rdv, model eta (η) servo drive, cosine

Table 2-65. Rendezvous Servo System, Computer Test (Cont)

	RENDEZVOUS SERVO SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS										INPUT SIGNALS TO VISUAL SYSTEM	
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
14	RENDEZVOUS MODEL ZETA (ζ) SERVO DRIVE	The rendezvous model zeta (ζ) servo drive will rotate from 0.0 to 360.0 degrees. The rate of rotation may vary from 0.03 to 10.0 degrees/second. A programmable stop (freeze point) may be entered between 0.0 and 360.0 degrees. For additional freeze point entry, refer to paragraph 2-35.	R	14	0.03	10.0	deg/sec	0.0		360.0	deg	D/A 367 D/A 368	VCEPST1 VCEPST2	Rdv, model zeta (ζ) servo drive, sine Rdv, model zeta (ζ) servo drive, cosine
15	RENDEZVOUS SUN ROTATIONAL SERVO DRIVE	The rendezvous sun rotational servo drive will traverse from 0.0 to +180.0 degrees, back through 0.0 to -180.0 degrees, and back to 0.0 degrees. In effect, it generates motion about one axis of a two-degree of freedom system. The rate of rotation may vary between 0.67 and 67.0 degrees/second. A programmable stop (freeze point) may be entered between -180.0 and +180.0 degrees. If the first programmable stop is positive, the stop will occur in the positive going direction. If the first programmable stop is negative, the servo will first swing to the positive end point, swing back through 0.0 degrees and stop at the indicated freeze point. If any entered programmable stop is algebraically less than the previous amount entered, the servo will first swing to the end point and stop on the return. For additional freeze point entry, refer to paragraph 2-35.	R	15	0.67	67.0	deg/sec	0.0	0.0	0.0	deg	D/A 362 D/A 363	VCELAS1 VCELAS2	Rdv, sun rotational servo drive, sine Rdv, sun rotational servo drive, cosine
16	RENDEZVOUS SUN TRANSLATIONAL SERVO DRIVE	The rendezvous sun translational servo drive will traverse from -13.0 to -34.0 degrees and back to -13.0 degrees. The rate of rotation may vary between 0.03 and 53.7 degrees/second. For additional freeze point entry, refer to paragraph 2-35.	R	16	0.03	53.7	deg/sec	-13.0	-34.0	-13.0	deg	D/A 364	VCERHS	Rdv, sun translational servo drive

Table 2-66. Sextant/Telescope Display System, Computer Test

			DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS										INPUT SIGNALS TO VISUAL SYSTEM	
	SEXTANT/TELESCOPE SYSTEM		Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
1	INITIALIZATION OF THE TELESCOPE DISPLAY SYSTEM	All device channels associated with the telescope display system are set to their initial positions. (Tests X2 to X7.)	X	1	0.0			0.0						All device channels associated with telescope. (Tests X2 to X7.)
2	TELESCOPE RETICLE SERVO DRIVE	The telescope reticle servo drive is a continuous rotation servo which positions the telescope reticle to be coincident with the telescope shaft axis rotation. The telescope reticle servo drive will rotate over the range from 0.0 to 360.0 degrees. The rate of rotation may vary between 0.2 and 20.0 degrees/second. A programmable stop (freeze point) may be entered between 0.0 and 360.0 degrees. Refer to paragraph 2-35 for additional freeze point entry.	X	2	0.2	20.0	deg/sec	0.0		360.0	deg	D/A 295 D/A 296	VDSINAS VDCOSAS	Telescope reticle servo drive, sine Telescope reticle servo drive, cosine
3	TELESCOPE OCCULTING MECHANISM (LEFT BLADE) SERVO DRIVE	The telescope occulting mechanism (left blade) servo drive will traverse over a range from 0.0 to 118.8 degrees and back to 0.0 degrees. The rate of rotation may vary between 0.2 and 20.0 degrees/second. A programmable stop (freeze point) may be entered between 0.0 and 118.8 degrees. The first programmable stop entry will cause the stop to occur in the positive going direction. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. For additional freeze point entry, refer to paragraph 2-35.	X	3	0.2	20.0	deg/sec	0.0	118.8	0.0	deg	D/A 301 D/A 302	VBSPHLB VBCPHLB	Telescope occ. mechanism (left blade) servo drive, sine Telescope occ. mechanism (left blade) servo drive, cos
4	TELESCOPE OCCULTING MECHANISM (RIGHT BLADE) SERVO DRIVE	The telescope occulting mechanism (right blade) servo drive will traverse over the range from 0.0 to 118.8 degrees and back to 0.0 degrees. The rate of rotation may vary between 0.2 and 20.0 degrees/second. A programmable stop (freeze point) may be	X	4	0.2	20.0	deg/sec	0.0	118.8	0.0	deg	D/A 299 D/A 300	VBSPHRB VBCPHRB	Telescope occ. mechanism (right blade) servo drive, sin Telescope occ. mechanism (right blade) servo drive, cos

Table 2-66. Sextant/Telescope Display System, Computer Test (Cont)

	SEXTANT/TELESCOPE SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		entered between 0.0 and 118.8 degrees. The first programmable stop entry will cause the stop to occur in the positive going direction. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. For additional freeze point entry. Refer to paragraph 2-35.												
5	TELESCOPE OCCULTING MECHANISM (VERTICAL BLADES) SERVO DRIVE	The telescope occulting mechanism (vertical blades) servo drive will traverse over the range from 0.0 to +56.7 degrees, back through 0.0 to -66.6 degrees and back to 0.0 degrees. The rate of rotation may vary between 0.2 and 20.0 degrees/second. A programmable stop (freeze point) may be entered between -66.6 and 56.7 degrees. If the first programmable stop entry is greater than 0.0 degrees, the stop will occur in the positive going direction. If the first programmable stop entry is not greater than 0.0 degrees, the servo drive will first traverse to +56.7 degrees, and then drive negatively to the negative freeze point. Whenever an entered programmable stop is not algebraically greater in magnitude than the previous amount, the stop will occur after swinging to the end point. For additional freeze point entry, refer to paragraph 2-35.	X	5	0.2	20.0	deg/sec	0.0	0.0	0.0	deg	D/A 297 D/A 298	VBSPHFAB VBCPHFAB	Telescope occ. mech. (vert. blade) servo drive, sine Telescope occ. mech. (vert. blade) servo drive, cos
6	TELESCOPE SUNSHAFT CONTROL (ON-DB0 SET)	The telescope sunshaft control (ON-DB0 Set) performs the function its title implies. In effect, it turns the sun on by setting the DB0. An additional feature of this test is that it accepts a delay parameter. That is a delay from 10.0 seconds to 100.0 seconds can be effected before the DB0 is set.	X	6	10.0	100.0	sec	0.0				DB0 329	V310	Telescope sunshaft control (DB0 set)

Table 2-66. Sextant/Telescope Display System, Computer Test (Cont)

	SEXTANT/TELESCOPE SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
7	TELESCOPE SUNSHAFT CONTROL (OFF-DB0 OF X6 RESET)	The telescope sunshaft control (OFF-DB0 of X6 Reset) performs the function its title implies. In effect, it turns the sun off by resetting the DB0 set in test X6. An additional feature of this test is that it accepts a delay parameter. That is a delay from 10.0 to 100.0 seconds can be effected before the DB0 is reset.	X	7	10.0	100.0	sec	0.0						
8	INITIALIZATION OF SEXTANT DISPLAY SYSTEM	All device channels associated with the sextant display routine are set to their initial positions (Tests X9 to X26).	X	8	0.0			0.0						All device channels associated with sextant routine (X9 to X26)
9	SEXTANT RETICLE SERVO DRIVE	The sextant reticle servo drive is a continuous rotation servo which positions the sextant reticle to be coincident with the sextant shaft axis rotation. The sextant reticle servo drive will rotate over the range from 0.0 to 360.0 degrees. The rate of rotation may vary between 0.2 and 20.0 degrees/second. A programmable stop (freeze point) may be entered between 0.0 and 360.0 degrees. Refer to paragraph 2-35 for additional freeze point entry.	X	9	0.2	20.0	deg/sec	0.0		360.0	deg	DW0D 20	VPHISR	Sextant reticle servo drive
10	SEXTANT DEROTATION PRISM SERVO DRIVE	The sextant derotation prism servo drive will traverse over the range from 0.0 to +180.0 degrees, back through 0.0 to -180.0 degrees, and back through 0.0 degrees. The rate of rotation may vary between 0.2 and 20.0 degrees/second. A programmable stop (freeze point) may be entered between -180.0 and +180.0 degrees. If the first programmable stop entry is positive, the stop will occur in the positive going direction. If the first programmable stop is negative, the servo drive will traverse +180.0 degrees and drive back through 0.0 to the freeze point indicated by the pro-	X	10	0.2	20.0	deg	0.0	0.0	0.0	deg	D/A 287 D/A 288	VASNPHDP VACSPHDP	Sex. derotation prism servo drive, sine Sex. derotation prism servo drive, cos

Table 2-66. Sextant/Telescope Display System, Computer Test (Cont)

	SEXTANT/TELESCOPE SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channels Description
		grammable stop is algebraically less than the previous amount entered, the stop will occur after the end swing in the opposite direction of rotation. Refer to paragraph 2-35 for additional freeze point entry.												
11	SEXTANT VARIABLE MAGNIFICATION SERVO DRIVE	The variable magnification servo will traverse from 0.0 to +177.0 degrees, and back to 0.0 degrees. The rate of rotation may vary from 0.2 to 20.0 degrees/second. A programmable stop (freeze point) may be entered between 0.0 and +177.0 degrees. The first entry will cause a stop to occur in the positive going direction. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. Refer to paragraph 2-35 for additional freeze point entry.	X	11	0.2	20.0	deg/sec	0.0	177.0	0.0	deg	DW0D 21	VAPSVM	Sex. variable magnification servo drive
12	SEXTANT SLIDE SELECTION SERVO DRIVE (CAROUSEL DRIVE)	The slide selection servo drive (carousel drive) displays a desired slide according to the decimal input from 1.0 to 90.0.	X	12	1.0	90.0	dec	0.0				DW0R 22	VASDLM	Sex. slide selection servo drive (carousel drive)
13	SEXTANT STARFIELD SERVO DRIVE	The starfield servo drive will traverse over the range from 0.0 to +180.0 degrees, back through 0.0 to -180.0 degrees, and back to 0.0 degrees. The rate of rotation may vary between 0.2 and 20.0 degree/second. A programmable stop (freeze point) may be entered between -180.0 and +180.0 degree. If the first programmable stop is positive, the stop will occur in the positive going direction. If the first programmable stop is negative, the servo will first drive to +180.0 degrees, return to 0.0 degrees and stop at the indicated freeze point.	X	13	0.2	20.0	deg/sec	0.0	0.0	0.0	deg	D/A 285 D/A 286	VASNPHSP VACSPHSP	Sex. starfield servo drive, sine Sex. starfield servo drive, cos

Table 2-66. Sextant/Telescope Display System, Computer Test (Cont)

	SEXTANT/TELESCOPE SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channels Description
		Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur after the swing through the end point. For additional freeze point entry, refer to paragraph 2-35.												
14	SEXTANT STARFIELD SELECTION SERVO DRIVE	The starfield selection servo drive displays the desired star group according to the decimal input from 1.0 to 27.0.	X	14	1.0	27.0	dec	0.0				DWØR 23	VAXSSD	Sex. starfield selection servo drive
15	SEXTANT LANDMARK SLIDE IMAGE "α (ALPHA)" SERVO DRIVE	The sextant landmark slide image "α" servo drive will traverse over the range from 0.0 to +89.0 degrees, and back to 0.0 degrees. The rate of rotation may vary between 0.24 and 24.0 degrees/minute. A programmable stop (freeze point) may be entered between -89.0 and +89.0 degrees. If the first programmable stop is positive, the stop will occur in the positive going direction. If the first programmable stop is negative, the servo will first drive to +89.0 degrees, return to 0.0 degrees and stop at the indicated freeze point. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur after the swing through the end point. For additional freeze point entry, refer to paragraph 2-35.	X	15	0.24	24.0	deg/min	0.0	0.0	0.0	deg	D/A 289 D/A 290 DWØD 31	VASNALIC VACSALLC VAALLF	Sex. landmark slide image α servo drive, sine Sex. landmark slide image α servo drive, cosine Sex. landmark slide image α servo drive, D/R drive
16	SEXTANT LANDMARK SLIDE IMAGE "β (BETA)" SERVO DRIVE	The sextant landmark slide image "β" servo drive will traverse over the range from 0.0 to +175.0 degrees, back through 0.0 to -175.0 degrees, and back to 0.0 degrees. The rate of rotation may vary between 0.24 and 24.0 degrees/minute. A programmable stop (freeze point) may be entered between -175.0 and +175.0 degrees. If the first programmable stop is	X	16	0.24	24.0	deg/min	0.0	0.0	0.0	deg	D/A 291 D/A 292 DWØD 32	VASNBELC VACSBELC VABELF	Sex. landmark slide image "β" servo drive, sine Sex. landmark slide image "β" servo drive, sine Sex. landmark slide image "β" servo drive, D/R drive

Table 2-66. Sextant/Telescope Display System, Computer Test (Cont)

SEXTANT/TELESCOPE SYSTEM			DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		negative, the servo will first drive to +89.0 degrees, return to 0.0 degrees and stop at the indicated freeze point. Whenever entered programmable stop is not algebraically greater than the previous amount, the stop is not algebraically greater than the previous amount, the stop will occur after the swing through the end point. For additional freeze point entry, refer to paragraph 2-35.												
17	SEXTANT STARFIELD IMAGE "α (ALPHA)" SERVO DRIVE	The sextant starfield image "α" servo drive will traverse over the range from 0.0 to +89.0 degrees, back through 0.0 to -89.0 degrees, and back to 0.0 degrees. The rate of rotation may vary between 0.24 to 24.0 degrees/minute. A programmable stop (freeze point) may be entered between -89.0 and +89.0 degrees. If the first programmed to stop is positive, the stop will occur in the positive going direction. If the first programmable stop is negative, the servo will first drive to +89.0 degrees, return to 0.0 degrees and stop at the indicated freeze point. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur after the swing through the end point. For additional freeze point entry, refer to paragraph 2-35.	X	17	0.24	24.0	deg/min	0.0	0.0	0.0	deg	D/A 281 D/A 282 DWØD 29	VASNALSC VACSALSC VAALSF	Sex. starfield image "α" servo drive, sine Sex. starfield image "α" servo drive, cosine Sex. starfield image "α" servo drive, D/R drive
18	SEXTANT STARFIELD IMAGE "β (BETA)" SERVO DRIVE	The sextant starfield image "β" servo drive will traverse over the range from 0.0 to +175.0 degrees, back through 0.0 to -175.0 degrees, and back to 0.0 degrees. The rate of rotation may vary between 0.24 to 24.0 degrees/minute. A programmable stop (freeze point) may be entered between -175.0 and +175.0	X	18	0.24	24.0	deg/min	0.0	0.0	0.0	deg	D/A 283 D/A 284 DWØD 30	VASNBESC VACSBESC VABESF	Sex. starfield image "β" servo drive, sine Sex. starfield image "β" servo drive, cosine Sex. starfield image "β" servo drive, D/R drive

Table 2-66. Sextant/Telescope Display System, Computer Test (Cont)

	SEXTANT/TELESCOPE SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		degrees. If the first programmable stop is positive, the stop will occur in the positive going direction. If the first programmable stop is negative, the servo will first drive to +89.0 degrees, return to 0.0 degrees and stop at the indicated freeze point. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur after the swing through the end point. For additional freeze point entry, refer to paragraph 2-35.												
19	SEXTANT POLAROID ROTATION SERVO DRIVE	The sextant polaroid rotation servo drive will rotate from 0.0 to 360.0 degrees. The rate of rotation may vary between 0.2 and 24.0 degrees/second. A programmable stop (freeze point) may be entered between 0.0 and 360.0 degrees. For additional freeze point entry, refer to paragraph 2-35 .	X	19	0.2	20.0	deg/sec	0.0		360.0	deg	D/A 293 D/A 294	VASNPHPL VACSPHPL	Sex. polaroid rotation servo drive, sine Sex. polaroid rotation servo drive, cosine
20	SEXTANT SUNSHAFT CONTROL (ON-DBØ SET)	The sextant sunshaft control (ON-DBØ Set) performs the function its title implies. In effect, it turns the sun on by setting the DBØ. An additional feature of this test is that it accepts a delay parameter. That is, a delay from 10.0 to 100.0 seconds can be effected before the DBØ is set.	X	20	10.0	100.0	sec	0.0				DBØ 330	V320	Sex. sunshaft control (DBØ set)
21	SEXTANT SUNSHAFT CONTROL (OFF-DBØ OF X20 RESET)	The sextant sunshaft control (OFF-DBØ of X20 reset) performs the function its title implies. In effect, it turns the sun off by resetting the DBØ set in test X20. An additional feature of this test is that it accepts a delay parameter. That is, a delay from 10.0 to 100.0 seconds can be effected before the DBØ is reset.	X	21	10.0	100.0	sec	0.0						

Table 2-66. Sextant/Telescope Display System, Computer Test (Cont)

	SEXTANT/TELESCOPE SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
22	SEXTANT LANDMARK INTENSITY CONTROL (MEDIUM)	The sextant landmark intensity control (medium) sets the light intensity to medium. In effect, it accomplishes this by setting one DB0 and resetting two. (The two DB0's of X23 and X24.) This test contains a 10.0 to 100.0 second delay parameter.	X	22	10.0	100.0	sec	0.0				DB0 333	V323	Sex. landmark intensity control (medium)-(DB0 set)
23	SEXTANT LANDMARK INTENSITY CONTROL (LOW)	The sextant landmark intensity control (low) sets the light intensity to low. In effect it accomplishes this by setting one DB0 and resetting two (the two DB0's of X21, and X24). This tests contains a 10.0 to 100.0 second delay parameter.	X	23	10.0	100.0	sec	0.0				DB0 334	V324	Sex. landmark intensity control (low)-(DB0 set)
24	SEXTANT LANDMARK INTENSITY CONTROL (HIGH)	The sextant landmark intensity control (high) sets the light intensity to high. In effect, it accomplishes this by setting one DB0 and resetting two (the two DB0's of X21 and X24). This test contains a 10.0 to 100.0 second delay parameter.	X	24	10.0	100.0	sec	0.0				DB0 332	V322	Sex. landmark intensity control (high)-(DB0 set)
25	SEXTANT STARFIELD ILLUMINATION (OFF) - (DB0 RESET)	The sextant starfield illumination (OFF) turns the starfield illumination off. In effect, it resets the DB0 listed in test X26. An additional feature of this test is that it accepts a delay parameter from 10.0 to 100.0 seconds.	X	25	10.0	100.0	sec	0.0						
26	SEXTANT STARFIELD ILLUMINATION (ON) - (DB0 SET)	The sextant starfield illumination (ON) turns on the starfield illumination. In effect, it sets the DB0. An additional feature of this test is that it accepts a delay parameter from 10.0 to 100.0 seconds.	X	26	10.0	100.0	sec	0.0				DB0 299	V364	Sex. starfield illumination (on)-(DB0 set)

Table 2-67. Starfield Display Routine, Computer Test

	STARFIELD DISPLAY ROUTINE		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
1	INITIALIZATION OF STARFIELD DISPLAY ROUTINE	All the devices associated with the Starfield Display routine are set to their initial positions.	S	1	0.0			0.0						All channels associated with Starfield Display Routine
2	CELESTIAL SPHERE ROLL DRIVE	The Celestial Sphere roll drive will rotate from 0 degrees to 720 degrees. The desired rate of rotation may vary from 0.1 degrees/second to 40.0 degrees/second. A programmable stop (freeze point) may be entered between 0 degrees and 720 degrees. Refer to paragraph 2-35 for entering additional freeze point entry.	S	2	0.0	40.0	deg/sec	0.0		720.0	deg	D/A 305 D/A 306 D/A 311 D/A 312 D/A 317 D/A 318 D/A 323 D/A 324 D/A 329 D/A 330	VDSPSSF1 VDCPSSF1 VDSPSSF2 VDCPSSF2 VDSPSSF3 VDCPSSF3 VDSPSSF4 VDCPSSF4 VDSPSSF5 VDCPSSF5	C/S, roll drive, sine, ld window, No. 1 C/S, roll drive, cosine, ld window No. 1 C/S, roll drive, sine, rdv window, No. 2 C/S, roll drive, cosine, rdv window, No. 2 C/S, roll drive, sine, rdv window, No. 4 C/S, roll drive, cosine, rdv window, No. 4 C/S, roll drive, sine, ld window, No. 5 C/S, roll drive, cosine, ld window, No. 5 C/S, roll drive, sine, telescope C/S, roll drive, cosine, telescope
3	CELESTIAL SPHERE PITCH DRIVE	The Celestial Sphere pitch drive will rotate from 0 degrees to 720 degrees. The desired rate of rotation may vary from 0.1 degrees/second to 40.0 degrees/second. A programmable stop (freeze point) may be entered between 0 degrees and 720 degrees. Refer to paragraph 2-35 for entering additional freeze point entry.	S	3	0.1	40.0	deg/sec	0.0		720.0	deg	D/A 303 D/A 304 D/A 309 D/A 310 D/A 315 D/A 316 D/A 321 D/A 322 D/A 327 D/A 328	VDSTHSF1 VDCTHSF1 VDSTHSF2 VDCTHSF2 VDSTHSF3 VDCTHSF3 VDSTHSF4 VDCTHSF4 VDSTHSF5 VDCTHSF5	C/S, pitch drive, sine, ld window, No. 1 C/S, pitch drive, cosine, ld window, No. 1 C/S, pitch drive, sine, rdv window, No. 2 C/S, pitch drive, cosine, rdv window No. 2 C/S, pitch drive, sine, rdv window, No. 4 C/S, pitch drive, cosine, rdv window, No. 4 C/S, pitch drive, sine, ld window, No. 5 C/S, pitch drive, cosine, ld window. No. 5 C/S, pitch drive, sine, telescope C/S, pitch drive, cosine, telescope
4	CELESTIAL SPHERE YAW DRIVE	The Celestial Sphere yaw drive will rotate from 0 degrees to 720 degrees. The desired rate of rotation may vary from 0.1 degrees/second to 40.0 degrees/second. A programmable stop (freeze point) may be entered between 0 degrees and 720 degrees. Refer to paragraph 2-35 for additional freeze point entry.	S	4	0.1	40.0	deg/sec	0.0		720.0	deg	D/A 307 D/A 308 D/A 313 D/A 314 D/A 319 D/A 320 D/A 325 D/A 326 D/A 331 D/A 332	VDSPHSF1 VDCPHSF1 VDSPHSF2 VDCPHSF2 VDSPHSF3 VDCPHSF3 VDSPHSF4 VDCPHSF4 VDSPHSF5 VDCPHSF5	C/S, yaw drive, sine, ld window, No. 1 C/S, yaw drive, cosine, ld window, No. 1 C/S, yaw drive, sine, rdv window. No. 2 C/S, yaw drive, cosine, rdv window, No. 2 C/S, yaw drive, sine, rdv window, No. 4 C/S, yaw drive, cosine, rdv window, No. 4 C/S, yaw drive, sine, ld window, No. 5 C/S, yaw drive, cosine, ld window, No. 5 C/S, yaw drive, sine, telescope C/S, yaw drive, cosine, telescope
5	OCCULTATION "X" AXIS SERVO DRIVE (EARTH/MOON)	The Occultation "X" Axis Servo Drive will traverse from -142.188 degrees to +142.188 degrees and back to -142.188 degrees. The rate of rotation may vary from 0.4 degrees/second to 40.0 degrees/second. A programmable stop (freeze point) may be	S	5	0.4	40.0	deg/sec	-142.188	142.188	-142.188	deg	D/A 338 D/A 339 D/A 340	VFEY01EM VFEY02EM VFEY03EM	Occ "X" axis servo drive (e/m) ld window, No. 1 Occ "X" axis servo drive (e/m) rdv window No. 2 Occ "X" axis servo drive (e/m) rdv window, No. 4

Table 2-67. Starfield Display Routine, Computer Test (Cont)

	STARFIELD DISPLAY ROUTINE		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		entered between -142.188 degrees and +142.188 degrees. The first entry will cause a stop to occur in the positive going direction. A stop at 0 degrees must be entered as "-0.0". Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. Refer to paragraph 2-35 for additional freeze point entry.										D/A 341 D/A 342	VFEY04EM VFEY05EM	Occ "X" axis servo drive (e/m) ld window No. 5 Occ "X" axis servo drive (e/m) telescope
6	OCCULTATION "Y" AXIS SERVO DRIVE (EARTH/MOON)	The Occultation "Y" Axis Servo Drive will traverse from -142.188 degrees to +142.188 degrees and back to -142.188 degrees. The rate of rotation may vary from 0.4 degrees/second to 40.0 degrees/second. A programmable stop (freeze point) may be entered between -142.188 degrees and +142.188 degrees. The first entry will cause a stop to occur in the positive going direction. A stop at 0 degrees must be entered as "-0.0". Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. Refer to paragraph 2-35 for additional freeze point entry.	S	6	0.4	40.0	deg/sec	-142.188	142.188	-142.188	deg	D/A 343 D/A 344 D/A 345 D/A 346 D/A 347	VFEZ01EM VFEZ02EM VFEZ03EM VFEZ04EM VFEZ05EM	Occ "Y" axis servo drive (e/m) ld window, No. 1 Occ "Y" axis servo drive (e/m) rdv window, No. 2 Occ "Y" axis servo drive (e/m) rdv window, No. 4 Occ "Y" axis servo drive (e/m) ld window, No. 5 Occ "Y" axis servo drive (e/m) telescope
7	OCCULTATION "Z" AXIS SERVO DRIVE (EARTH/MOON)	The Occultation "Z" Axis Servo Drive will traverse from +6.0 degrees and back to +6.0 degrees. The rate of rotation may vary from 0.005 degrees/second to 0.1 degrees/second. A programmable stop (freeze point) may be entered between +6.0 degrees and +168.24 degrees. The first entry will cause a stop to occur in the positive going direction. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going	S	7	0.005	0.1	deg/sec	6.0	168.24	6.0	deg	D/A 333 D/A 334 D/A 335 D/A 336 D/A 337	VFED01EM VFED02EM VFED03EM VFED04EM VFED05EM	Occ "Z" axis servo drive (e/m) ld window, No. 1 Occ "Z" axis servo drive (e/m) rdv window, No. 2 Occ "Z" axis servo drive (e/m) rdv window, No. 4 Occ "Z" axis servo drive (e/m) ld window No. 5 Occ "Z" axis servo drive (e/m) telescope

Table 2-67. Starfield Display Routine, Computer Test (Cont)

	STARFIELD DISPLAY ROUTINE		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		direction. Refer to paragraph 2-35 for additional freeze point entry.												
8	OCCULTATION "Z" AXIS SERVO DRIVE (EARTH/ MOON) INCREASED REAL RATE (X 100)	The Occultation "Z" Axis Servo Drive Increased Real Rate (X100) is a +28 vdc application that accomplishes just what its name implies. It increases the drive rate. In effect, a DB0 is set.	S	8	0.0			0.0				DB0 343	V010	Occ "Z" axis servo drive (e/m) increase real (normal) rate (x100)
9	OCCULTATION "Z" AXIS SERVO DRIVE (EARTH/ MOON) RETURN TO NORMAL RATE (RESET DB0 OF S8)	The Occultation "Z" Axis Servo Drive Return to Normal Rate is the negate of the preceeding test. In effect, it resets the DB0 set in the preceeding test.	S	9	0.0			0.0						
10	OCCULTATION "X" AXIS SERVO DRIVE (LEM)	The Occultation "X" Axis Servo Drive will traverse from -142.188 degrees to +142.188 degrees and back to -142.188 degrees. The rate of rotation may vary from 0.4 degrees/second to 40.0 degrees/second. A programmable stop (freeze point) may be entered between -142.188 degrees. The first entry will cause a stop to occur in the positive going direction. A stop at 0 degrees must be entered as "-0.0". Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. Refer to paragraph 2-35 for additional freeze point entry.	S	10	0.4	40.0	deg/sec	-142.188	142.188	-142.188	deg	D/A 350 D/A 351	VFEY0M6T VFEY0M7T	Occ "X" axis servo drive (LEM) rdv window, No. 2 Occ "X" axis servo drive (LEM) rdv window, No. 4
11	OCCULTATION "Y" AXIS SERVO DRIVE (LEM)	The Occultation "Y" Axis Servo Drive will traverse from -142.188 degrees to +142.188 degrees and back to -142.188 degrees. The rate of rotation may vary from 0.4 degrees/second to 40.0 degrees/second. A programmable stop (freeze point) may be entered between -142.188 degrees and +142.188 degrees. The first entry will cause a stop to occur in the posi-	S	11	0.4	40.0	deg/sec	-142.188	142.188	-142.188	deg	D/A 352 D/A 353	VFEZ0M6T VFEZ0M7T	Occ "Y" axis servo drive (LEM) rdv window No. 2 Occ "Y" axis servo drive (LEM) rdv window No. 4

Table 2-67. Starfield Display Routine, Computer Test (Cont)

	STARFIELD DISPLAY ROUTINE		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		tive going direction. A stop at 0 degrees must be entered as "-0.0". Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. Refer to paragraph 2-35 for additional freeze point entry.												
12	OCCULTATION "Z" AXIS SERVO DRIVE (LEM)	The Occultation "Z" Axis Servo Drive will traverse from +6.0 degrees to +87.12 degrees and back to +6.0 degrees. The rate of rotation may vary from 0.02 degrees/second to 1.0 degrees/second. A programmable stop (freeze point) may be entered between +6.0 degrees and +87.12 degrees. The first entry will cause a stop to occur in the positive going direction. Whenever an entered programmable stop is not algebraically greater than the previous amount, the stop will occur in the negative going direction. Refer to paragraph 2-35 for additional freeze point entry.	S	12	0.02	1.0	deg/sec	6.0	87.12	6.0	deg	D/A 348 D/A 349	VFED0M6T VFED0M7T	Occ "Z" axis servo drive (LEM) rdv window. No. 2 Occ "Z" axis servo drive (LEM) rdv window. No. 4
13	OCCULTATION "Z" AXIS SERVO DRIVE (LEM) INCREASED REAL RATE (X100)	The Occultation "Z" Axis Servo Drive Increased Real Rate (X100) is a +28 vdc application that accomplishes just what its name implies. It increases the drive rate. In effect, a DB0 is set.	S	13	0.0			0.0				DB0 348	V060	Occ "Z" axis servo drive (LEM) increase real (normal) rate (x100)
14	OCCULTATION "Z" AXIS SERVO DRIVE (LEM) RETURN TO NORMAL RATE (RESET DB0 OF S13)	The Occultation "Z" Axis Servo Drive Return to Normal Rate is the negate of the preceding test. In effect, it resets the DB0 set in the preceding test.	S	14	0.0			0.0						

Table 2-67. Starfield Display Routine, Computer Test (Cont)

	RENDEZVOUS VIDEO SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
1	INITIALIZATION OF THE RENDEZVOUS VIDEO SYSTEM	All device channels associated with the rendezvous video system are set to their initial positions tests (V2 to V23).	V	1	0.0			0.0						All device channels associated with the rendezvous video system (tests V2 to V23)
2	RENDEZVOUS VIDEO CRT RASTER SIZE SERVO DRIVE (OUT)	The rendezvous video CRT raster size servo drive will change the raster size to simulate the range between 36.0 and 2412.0 feet. Thus, the servo will drive the raster size to appear that the C/M is moving away from the model. The rate of motion may vary between 0.4 and 40.0 feet/second. A programmable stop (freeze point) may be entered between 36.0 and 2412.0 feet. For additional freeze point entry, refer to paragraph 2-35.	V	2	0.4	40.0	fps	36.0		2412.0	feet	D/A 448 D/A 449	VCERS2 VCERS3	Rdv video CRT raster size servo drive, rdv wd, No. 2 Rdv video CRT raster size servo drive, rdv wd, No. 4
3	RENDEZVOUS VIDEO CRT RASTER SIZE SERVO DRIVE (IN)	The rendezvous video CRT raster size servo drive will change the raster size to simulate the range between 2412.0 and 36.0 feet. Thus, the servo will drive the raster size to appear that the C/M is moving towards the model. The rate of motion may vary between 0.4 and 40.0 feet/second. A programmable stop (freeze point) may be entered between 2412.0 and 36.0 feet. For additional freeze point entry, refer to paragraph 2-35.	V	3	0.4	40.0	fps	2412.0		36.0	feet	Same as results of test V2		
4	RENDEZVOUS VIDEO CRT RASTER DE-CENTERING "X" SERVO DRIVE (POSITIVE)	The rendezvous video CRT raster de-centering "X" servo drive provides for the horizontal image positioning on the CRT screen. The servo will drive the image from 0.0 degrees to +90.0 and back to 0.0 degrees. The rate of rotation may vary between 0.4 and 40.0 degrees/second. A programmable stop may be entered from 0.0 to +90.0 degrees. If an entered programmable stop is algebraically less than the preceding one, the servo will first drive to the end point, then stop at the indicated stop. For additional freeze point entry, refer to paragraph 2-35.	V	4	0.4	40.0	deg/sec	0.0	90.0	0.0	deg	D/AF 004 D/AF 005	VCEYCR2T VCEYCR3T	Rdv video CRT raster de-centering "X" servo drive, rdv window No. 2 Rdv video CRT raster de-centering "X" servo drive, rdv window No. 4

Table 2-67. Starfield Display Routine, Computer Test (Cont)

			DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
	RENDEZVOUS VIDEO SYSTEM		Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
5	RENDEZVOUS VIDEO CRT RASTER DE-CENTERING "X" SERVO DRIVE (NEGATIVE)	The rendezvous video CRT raster de-centering "X" servo drive provides for the horizontal image positioning on the CRT screen. The servo will drive the image from 0.0 to 90.0 degrees and back to 0.0 degrees. The rate of rotation may vary between 0.4 and 40.0 degrees/second. A programmable stop may be entered from 0.0 to -90.0 degrees. If an entered programmable stop is algebraically less than the preceeding one, the servo will first drive to the end point, then stop at the indicated stop. For additional freeze point entry, refer to paragraph 2-35.	V	5	0.4	40.0	deg/sec	0.0	-90.0	0.0	deg	Same as results of test V4		
6	RENDEZVOUS VIDEO CRT RASTER DE-CENTERING "Y" SERVO DRIVE (POSITIVE)	The rendezvous video CRT raster de-centering "Y" servo drive provides for the vertical image positioning on the CRT screen. The servo will drive the image from 0.0 to +90.0 degrees and back to 0.0 degrees. The rate of rotation may vary between 0.4 and 40.0 degrees/second. A programmable stop may be entered from 0.0 to +90.0 degrees. If an entered programmable stop is algebraically less than the preceeding one, the servo will first drive to the end point, then stop at the indicated freeze point on the return. For additional freeze point entry, refer to paragraph 2-35.	V	6	0.4	40.0	deg/sec	0.0	90.0	0.0	deg	D/AF 006 D/AF 007	VCEZCR2T VCEZCR3T	Rdv video CRT raster de-centering "Y" servo drive, rdv window No. 2 Rdv video CRT raster de-centering "Y" servo drive, rdv window No. 4
7	RENDEZVOUS VIDEO CRT RASTER DE-CENTERING "Y" SERVO DRIVE (NEGATIVE)	The rendezvous video CRT raster de-centering "Y" servo drive provides for the vertical image positioning on the CRT screen. The servo will drive the image from 0.0 to -90.0 degrees, and back to 0.0 degrees. The rate of rotation may vary between 0.4 and 40.0 degrees/second. A programmable stop may be entered from 0.0 to +90.0 degrees. If an entered programmable stop is algebraically less than the preceeding one, the servo will first drive	V	7	0.4	40.0	deg/sec	0.0	-90.0	0.0	deg	Same as results of test V6		

Table 2-67. Starfield Display Routine, Computer Test (Cont)

			DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
	RENDEZVOUS VIDEO SYSTEM		Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
		to the end point, then stop at the indicated freeze point on the return. For additional freeze point entry, refer to paragraph 2-35.												
8	RENDEZVOUS VIDEO MODEL TO SLIDE PROJECTOR TRANSFER (DB0 SET)	The rendezvous video model to slide projector transfer (DB0 set) essentially sets the DB0 enabling the transfer.	V	8	0.0			0.0				DB0 335	V003	Rdv video model to slide projector transfer
9	RENDEZVOUS VIDEO MODEL TO SLIDE PROJECTOR TRANSFER (DB0 RESET)	The rendezvous video model to slide projector transfer (DB0 reset) essentially resets the DB0 set in test V8.	V	9	0.0			0.0				Same as results of test V8		
10	RENDEZVOUS VIDEO SUN ILLUMINATION (DB0 SET)	The rendezvous video sun illumination (DB0 set) provides a point light source by turning on two mercury vapor lamps through the setting of the DB0. In essence, the sun is turned on.	V	10	0.0			0.0				DB0 336	V151	Rdv video sun illumination
11	RENDEZVOUS VIDEO SUN ILLUMINATION (DB0 RESET)	The rendezvous video sun illumination (DB0 reset) resets the DB0 set in test V10. In essence, it turns the sun off.	V	11	0.0			0.0				Same as results of test V10		
12	RENDEZVOUS VIDEO EARTH ILLUMINATION (PERIPHERAL LIGHTING) (DB0 SET)	The rendezvous video earth illumination (peripheral lighting) (DB0 set) provides a surface light source by turning on four mercury arc lamps through setting the DB0.	V	12	0.0			0.0				DB0 337	V152	Rdv video earth illumination (peripheral equipment)
13	RENDEZVOUS VIDEO EARTH ILLUMINATION (PERIPHERAL LIGHTING) (DB0 RESET)	The rendezvous video earth illumination (peripheral lighting) (DB0 reset) resets the DB0 set in test V12.	V	13	0.0			0.0				Same as results of test V12		
14	RENDEZVOUS VIDEO, VIDEO ON-OFF, RENDEZVOUS WINDOW NO. 2 (ON)	The rendezvous video, video ON-OFF, rendezvous window No. 2 (ON) turns the video on in rendezvous window No. 2 by setting a DB0.	V	14	0.0			0.0				DB0 340	V174	Rdv, video on-off, rdv window No. 2
15	RENDEZVOUS VIDEO, VIDEO ON-OFF, RENDEZVOUS WINDOW NO. 4 (ON)	The rendezvous video, video ON-OFF, rendezvous window No. 4 (ON) turns the video on in rendezvous window No. 4 by setting a DB0.	V	15	0.0			0.0				DB0 341	V175	Rdv, video on-off, rdv window No. 4

Table 2-67. Starfield Display Routine, Computer Test (Cont)

			DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
	RENDEZVOUS VIDEO SYSTEM		Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Initial Position	Turn Position	Final Position	Units	DCE Device	Program Symbol	Channel Description
16	RENDEZVOUS VIDEO, VIDEO ON-OFF, RENDEZVOUS WINDOW NO. 2 (OFF)	The rendezvous video, video ON-OFF, rendezvous window No. 2 (OFF) turns the video off in rendezvous window No. 2 by resetting the DBØ set in test V14.	V	16	0.0			0.0				Same as results of test V14		
17	RENDEZVOUS VIDEO, VIDEO ON-OFF, RENDEZVOUS WINDOW NO. 4 (OFF)	The rendezvous video, video ON-OFF, rendezvous window No. 4 (OFF) turns the video off in rendezvous window No. 4 by resetting the DBØ set in test V15.	V	17	0.0			0.0				Same as results of test V15		
18	SIMULATOR FREEZE (ON)	The simulator freeze (ON) sets a DBØ.	V	18	0.0			0.0				DBØ 342	V190	Simulator freeze
19	SIMULATOR FREEZE (OFF)	The simulator freeze (OFF) resets the DBØ set in V18.	V	19	0.0			0.0				Same as results of test V18		
20	RENDEZVOUS VIDEO, VIDEO LEVEL, RENDEZVOUS WINDOW NO. 2 (RANGE OUT)	The rendezvous video, video level, rendezvous window No. 2 (range out) checks the video gain control as a function of the range from 150.0 to 10,000.0 feet. The rate of motion may vary from 5.0 to 500.0 feet/second. A programmable stop may be entered from 150.0 and 10,000.0 feet. For additional freeze point entry, refer to paragraph 2-35.	V	20	5.0	500.0	fps	150.0		10,000.0	feet	D/A 360	VCEVL2	Rdv, video level, rdv window No. 2
21	RENDEZVOUS VIDEO, VIDEO LEVEL, RENDEZVOUS WINDOW NO. 4 (RANGE OUT)	The rendezvous video, video level, rendezvous window No. 4 (range out) checks the video gain control as a function of the range from 150.0 to 10,000.0 feet. The rate of motion may vary from 5.0 to 500.0 feet/second. A programmable stop may be entered from 150.0 and 10,000.0 feet. For additional freeze point entry, refer to paragraph 2-35.	V	21	5.0	500.0	fps	150.0		10,000.0	feet	D/A 361	VCEVL3	Rdv, video level, rdv window No. 4
22	RENDEZVOUS VIDEO, VIDEO LEVEL, RENDEZVOUS WINDOW NO. 2 (RANGE IN)	The rendezvous video, video level, rendezvous window No. 2 (range in) checks the video gain controls a function of the range from 10,000.0 to 150.0 feet. The rate of motion may vary from 5.0 to 500.0 feet/second. A programmable stop may be entered from 10,000.0 to 150.0 feet. For additional freeze point entry, refer to paragraph 2-35.	V	22	5.0	500.0	fps	10,000.0		150.0	feet	Same as results of test V20		

Table 2-67. Starfield Display Routine, Computer Test (Cont)

	RENDEZVOUS VIDEO SYSTEM		DIAGNOSTIC CONTROL WORD MESSAGE SYMBOL INPUTS									INPUT SIGNALS TO VISUAL SYSTEM		
			Test		First Parameter (Rate or Delay)			Second Parameter (Freeze Point)						
REF. NO.	Test Title	Test Description	Name	Number	Minimum	Maximum	Units	Position	Position	Position	Units	Device	Program Symbol	Channel Description
23	RENDEZVOUS VIDEO, VIDEO LEVEL, RENDEZVOUS WINDOW NO. 4 (RANGE IN)	The rendezvous video, video level, rendezvous window No. 4 (range in) check the video gain control as a function of the range from 10,000.0 to 150.0 feet. The rate of motion may vary from 5.0 to 500.0 feet/second. A programmable stop may be entered from 10,000.0 to 150.0 feet. For additional freeze point entry, refer to paragraph 2-35.	V	23	5.0	500.0	fps	10,000.0		150.0	feet	Same as results of test V21		

2-38. MANUAL TEST.

2-39. The manual tests are designed to assist the technician in the analysis of a malfunction. These manual tests are available for each section of the AMS visual system equipment. Manual tests would normally be used when the general location of a malfunction is known, when a time element is involved making the canned-programmed-computer test impractical, or if a malfunction occurs during an actual simulated flight.

2-40. TELESCOPE AND SEXTANT ELECTRONICS CABINET.

2-41. Prior to each 350-hour simulated mission operation, functional tests should be conducted for purposes of detecting and correcting malfunctions in the critical areas of system operation. Functional tests for the electronics cabinet consist of checking power application and servo loop response by using the test panel, power control panel, and the required test equipment. These tests are designed to aid in providing a quick check for overall system operability; they do not constitute detailed preventive maintenance procedures. When a malfunction is indicated, refer to Section III, Trouble Analysis for the probable cause.

2-42. Manpower and Equipment Requirements. Table 2-68 lists the requirements for manpower and communications required for performing functional tests.

Table 2-68. Functional Test Requirements

Manpower	Two electronics technicians
Communications	Intercom facilities between technician at electronics cabinet and associated stations.

2-43. Testing Procedures. The following procedures are required for conducting a typical functional test at the electronics cabinet.

2-44. Set all test panel manual directors at "zero" and set CAROUSEL SERVO and STARFIELD SELECTOR SERVO test panel switches at their initial positions.

2-45. Apply 60-cycle power by turning "on" three phase circuit breaker on the power control panel. Phase indicator lamps should glow. If one or more lamps do not, turn circuit breaker "off" and turn it "on" again. If after repeating this procedure several times, the three indicator lamps do not light, consult Section III, Trouble Analysis for probably causes.

2-46. Set on/off switches on d-c power supplies on "on". Red indicator lamps at each switch should glow.

2-47. Check power supply voltages by monitoring voltmeters mounted on front panels. The voltmeter on the 28-volt supply should read 28 volts ±1 volt. The voltmeter on the plus 12 volt supply for low level stages (PS3) should read 12.6 ±.5 volts. The high current ±12 volt power supplies for the d-c torque motor electronics (PS2 and PS4) should indicate 12.6 ±.5 volts each. If the plus 28 volts supply or the plus 12 volt low level supply is slightly out of tolerance, correction may be made by means of voltage adjustment controls on the front panel of the power supply.

CAUTION

> Before attempting to adjust the plus and minus 12 volt high current supplies, refer to Section III of this manual. These power supplies are slaved to one another and interlocked so that failure of either one results in failure of the other. During operation, this type of connection prevents a runaway condition from occurring with any of the d-c servos in the event that minus 12 volt power is not present.

2-48. Perform individual servo check. Each of the nine single speed servos represented by the single speed directors at top of the test panel may be checked as follows:

a. Disconnect three single input connections from bottom rear section of cabinet.

b. Connect a dummy director to signal input connection for servo to be tested.

c. Ensure that excitation for dummy director is of correct phase by starting checking procedures with servo capable of continuous rotation (rotating polaroid servo for example).

d. To ensure that servo is operational, "rock" test panel director back and forth about 30 degrees either side of 0, having observer watch output member. If servo appears to "track" satisfactorily, return test panel director to zero.

e. Set associated TEST/NORM switch at "NORM". Servo should move slightly or not at all. If servo rotates 180 degrees, excitation to external dummy director is of improper phase, and rotor excitation should be reversed.

f. Observe transient servo performance by setting external dummy director at approximately 30 degrees and operating TEST/NORM switch. This action applies 30 degrees command signal to servo. When TEST/NORM switch is operated, the servo should jump abruptly from its present position to its new position. After one or two oscillations the servo should come to rest in new position. The length of time required for any of nine single speed servos to come to rest should be less than one second. It is also possible to monitor transient servo performance electrically by connecting an oscilloscope to the ERROR terminals on the test panel and applying a 30 degree step signal. When the signal is applied the error should jump to a relatively large value (approximately 10 volts) and then, oscillating once or twice, return to zero. For servos employing tachometer feedback, behavior of the tachometer signal in response to a step input signal is somewhat different. In this case, the tachometer signal will increase from zero, climb to a relatively high value, and then, oscillating once or twice, return to zero.

g. Observe the torque of the servo. This is a qualitative check and is performed by manually displaying the output member of the servo and observing the resulting resistant torque or force. All above mentioned servos should appear relatively stiff. For example, in the case of the variable magnification servos, stiffness amounts to approximately 2000 pounds per inch with a maximum of approximately 25 pounds. When making the check, care should be taken to avoid injury to operator or damage to equipment.

CAUTION

Do not touch optical elements with bare hands.

h. Check carousel and starfield selection servos. These servos are checked according to essentially the same procedures as described in steps a. through g. Step commands are applied by turning the appropriate test panel selector switches with TEST/NORM switch in "TEST" position. Once it is determined that each of these servos is functioning properly, step the servo through each setting to determine if the associated DRC's are functioning properly. In making check, observe the servo output members for each selector switch position. For example, as the selector switch for the starfield selector servo is rotated through each of its 28 positions, the output member of the servo should index 28 times in equal increments. Similarly, as the carousel slide selector switches are rotated, the carousel should index to any one of its 90 positions.

i. Check the four 2-speed servos with the two-speed dummy director. Visual observation of servo performance in response to a step command input is similar to that observed for a single speed servo, however, electrically observed conditions are somewhat different. When the 1X test points are used to supply electrical readings, results are similar to

those obtained with single speed servos. However, when the 32X test points are used, the error goes through about two and one-half sinusoidal cycles before reaching its final position, at which time several oscillations are observed. (The one speed error, when the 30 degree step signal is applied, rises to a relatively large value and decreases steadily to its final position when only a few oscillations are observed.)

j. Check the two speed switching network. To properly complete checkout of the two speed servos, this check must be made in addition to the check for torque stiffness. The procedure is accomplished by manually displacing the servo by approximately five degrees and then slowly releasing it. The servo should not come to rest at any position other than its original null; the test should be made by rotating the servo in both directions. During the test, the action of the two-speed switching network can be sensed by the presence of an increased torque gradient after the servo has been manually displaced by about three degrees.

WARNING

Great care should be exercised in making this test since servos can produce forces of up to 40 pounds.

k. Check Illumination Sources

1. Operation of telescope reticle illumination circuit and sextant reticle illumination circuit are easily checked by having observer look in respective eyepieces while respective intensity controls on power control panel are varied. Illumination intensity should vary accordingly.

2. Operation of Sunshafting Lamps can be checked in a similar manner with operator observing lamps either directly or through eyepieces. Prior to check, SUNSHAFTING LAMP TEST/NORM Switch located on the rear of the Power Control Chassis must be set at "TEST".

3. Operation of Starfield Projector Lamps is checked by varying the starfield intensity control on the power control panel and checking that projector lamp intensity varies accordingly. Once check is complete, control should be returned to original setting.

4. Operation of Landmark Projector Lamp by first turning lamp "ON" by means of toggle switch mounted on the projector lamp housing and then checking the lamp for color and intensity. After test is made, switch should be turned "OFF" so that computer may regain control of lamp.

2-49. TELESCOPE DISPLAY EQUIPMENT, MANUAL TESTS. Following a functional test of the test resolvers for the telescope's operable assemblies

(included in the Sextant/Telescope Electronic Cabinet tests) the functional tests of the telescope are performed. These tests will serve to check out the landmark, starfield, and combined lines of sight and locate any discrepancies in the telescope optical system.

2-50. Manpower and Equipment Requirements. Three maintenance technicians are required for the performance of the functional tests. One technician, with optical instrument experience, is stationed at the telescope eyepiece in the command module, one electronic technician is stationed at the test and control panels in the electronics cabinet (unit 9), and the third technician, also electronically experienced, is stationed at the test panel in the MEP and celestial sphere electronics cabinet (unit 10). Communication between the three technicians is required for performance of the tests. The commands for operation of the assemblies are given by the technician at the telescope eyepiece.

2-51. Pre-Test Conditions. The following conditions must exist prior to performing functional testing of the telescope's operable assemblies. The test resolvers, dials, switches, rheostat control knobs, etc., referred to in the following instructions are mounted in the AMS sextant/telescope electronics cabinet (unit No. 9).

a. The primary power cables to the electronics cabinets (unit No. 9 and No. 10) must be energized.

b. The toggle switches on the test panel located in unit 2 are labeled TELESCOPE RETICLE SERVO, TELESCOPE VERTICAL OCCULTING SERVO, TELESCOPE LEFT OCCULTING SERVO, and TELESCOPE RIGHT OCCULTING SERVO and must be in the "TEST" position.

c. The dials, indicating the test resolver rotor angle, in each of the above panel sections must be zeroed.

d. On the power control panel, the three-pole circuit breaker for 60-cycle, 3-phase, 120-volt a-c power must be in the "on" (up) position, and the three indicator lights, one for each phase, must be illuminated.

e. The toggle switch in the 400-cycle a-c circuitry must be in the "on" position. The energizing of the reference voltage is indicated by the illumination of the indicator light above the three ampere fuse.

f. The rheostat knob labeled SUNSHAFTING INTENSITY, under TELESCOPE, must be turned counterclockwise to the limit stop.

g. The rheostat knob labeled RETICLE INTENSITY, under TELESCOPE, must be turned clockwise against the limit stop or set at the position to provide correct reticle illumination.

h. The toggle switch, located on the back of the power control panel must be placed in the "TEST" position, permitting manual control of the sun-shafting effect.
In addition to the above pre-test conditions, the power supply units in the electronics cabinet must be energized.

NOTE

> Refer to the MEP and celestial sphere functional test for further instructions concerning mandatory pre-test conditions.

2-52. Testing Procedure. Functional testing of the telescope operable components will servo not only to check out the electrical and mechanical functioning of the units, but will also prove the accuracy of the optical paths within allowable limits of error. The functional tests, listed in table 2-69 are performed by having the optical technician in the simulated command module issue the "commands" over the intercom system to the electronic technicians stationed at the electronics cabinet (units 9 and 10) as applicable. As an example, refer to the testing of the rotating reticle in table 2-69. If the image of the celestial sphere and/or the MEP test pattern (see required results a and f) does not appear sharply focussed on the plane of the reticle, an optical malfunction in the starfield, landmark, or combined lines of sight is indicated. Such a malfunction could be the improper positioning of one or more fixed optical elements in the telescope, or improper positioning of the celestial sphere and/or MEP. Failure to achieve the required results in any operational tests is indicative of an electrical or mechanical malfunction of the unit under test, and can be isolated to a specific malfunction through use of Section III, Trouble Analysis.

Table 2-69. Telescope Functional Tests

Commands	Procedures	Required Results
Rotating Reticle		
a. Energize the Celestial Sphere Illuminator with zero occultation.	a. Energize the Celestial Sphere Illuminator and Occulting Assembly and appropriately adjusted on Test Panel in Electronics Cabinet, Unit No. 10.	a. The Celestial Sphere is illuminated and an area representing the Telescope's 60° Field of View appears in focus through the Telescope eyepiece.
b. Simulate zeroing of Command Module attitude with reference to roll, pitch, and yaw motion.	b. Required operations are performed on Unit No. 10 Test Panel to simulate the commanded zeroing.	b. The Celestial Sphere will rotate and come to rest with Navigational Star Vega (Alpha Lyrae) approximately 10 arc minutes off shaft axis of the Telescope, as measured by the reticle's fiducial marks.
c. Supply the required rotation of the Celestial Sphere to bring Vega to dead center on the Telescope reticle; i.e., within the opening where the reticle's X and Y axes would intersect if extended inward.	c. Required operations are performed to rotate the Celestial Sphere so as to center Vega on the reticle.	c. The Celestial Sphere will rotate as required to center Vega on the exact center of the Telescope reticle.
d. Slowly rotate the reticle through 360° in both directions, first clockwise, then counterclockwise.	d. The test resolver on the Test Panel of Electronics Cabinet, Unit No. 9, labeled TELESCOPE RETICLE SERVO is slowly rotated through one complete revolution in both directions as indicated by the command.	d. The Telescope's reticle will rotate smoothly through two complete revolutions, one in each direction, and the Navigational Star Vega should remain within a circle not exceeding more than 4 arc minutes radius from the apparent intersection of the X and Y axes cross-hairs engraved on the reticle.
e. Slowly rotate the reticle through two complete and continuous revolutions, first clockwise, then counterclockwise.	e. The test resolver on the Test Panel is slowly turned in both directions as commanded.	e. The Telescope's reticle will rotate slowly and smoothly as commanded with Star Vega retaining position as described in d., above.
f. Command illumination of the MEP and presentation of the Test Pattern frame.	f. The required operations are performed on Unit 10 Test Panel.	f. The MEP Test Pattern will be sharply focussed, through the Telescope's eyepiece with the center of the pattern superimposed on the Navigational Test Star.
g. Simultaneously rotate the MEP Test Pattern and the Telescope's reticle, in clockwise direction, to the following four positions in sequence: 32°, 121°, 193°, and 286°. Pause rotation at each of the 4 positions with sufficient duration to estimate the 0.5° accuracy required.	g. The required operations are performed on Unit 10 Test Panel to rotate the MEP Test Pattern as commanded. At the same time the reticle rotation resolver on Unit 11 Test Panel is turned to the four commanded positions, as indicated on the test resolver dial.	g. The MEP Test Pattern and the rotating reticle will rotate to the four commanded positions. At each position the fiducial marks on the Test Pattern and the fiducial marks of the reticle should index within plus or minus 0.5° of accuracy.

Table 2-69. Telescope Functional Tests (Cont)

Commands	Procedures	Required Results
Rotating Reticle (Cont)		
h. Command zeroing of MEP test pattern and reticle, followed by simultaneous counterclockwise positioning rotation to: 33°, 245°, 175° and 85°, with a pause at each position, as designated in g., above.	h. Perform the required operations on both test panels to comply with the command.	h. The Test Pattern rotating reticle will rotate together in the counterclockwise direction with fiducial marks indexing at the four positions within plus or minus 0.5° of accuracy.
i. Command sequential diminution and intensification of the reticle's illumination.	i. Move the rheostat on the Power Control Panel in Unit No. 9 labeled RETICLE INTENSITY (TELESCOPE portion of panel) counterclockwise to the limit stop and then clockwise to the indexed marking.	i. The edge-lighting illumination of the reticle will diminish, followed by intensification to normal intensity. All fiducial marks and numbering must be legible over the entire range of illumination.
Command Module Occulting		
a. Command complete occultation of the Telescope's Field of View from right to left.	a. Turn the resolver labeled TELESCOPE RIGHT OCCULTING SERVO on the test panel in Unit No. 9 clockwise through 140°.	a. The Telescope's reticle will undergo complete occultation from right to left.
b. Command restoration of zero occultation.	b. Turn the test resolver counterclockwise to 0°.	b. The clear aperture of the Telescope's Field of View will be restored by movement of the Right Occulting Blade from left to right.
c. Command complete occultation from left to right.	c. Turn the resolver labeled TELESCOPE LEFT OCCULTING SERVO on the Test Panel clockwise to 140°.	c. Complete occultation of the reticle will occur from left to right.
d. Command restoration of zero occultation.	d. Turn the test resolver counterclockwise to 0°.	d. Restoration of zero occultation will occur from right to left.
e. Command simulated maximum occultation of the Field of View by the lower edge of the navigation window.	e. Turn the resolver labeled TELESCOPE VERTICAL OCCULTING SERVO on the Test Panel clockwise to approximately 90°.	e. The Vertical Occulting Blade will occult the clear aperture from the bottom upward to at least 4° above the reticle's horizontal cross-hair.
f. Command zero occultation.	f. Turn the test resolver counterclockwise to 0°.	f. The Vertical Occulting Blade will move in the opposite direction, restoring zero occultation of the clear aperture.
g. Command simulated maximum occultation of the Field of View by the upper edge of the navigation window.	g. Repeat procedures e. and f. with the vertical occulting test resolver, except the rotation is counterclockwise to 270° and clockwise return to 0°.	g. The Vertical Occulting Blade will produce occultation from the top downward to at least 4° below the reticle's horizontal cross-hair, followed by reverse blade movement until zero occultation is restored.

Table 2-69. Telescope Functional Tests (Cont)

Commands	Procedures	Required Results
Command Module Occulting (Cont)		
h. Command four conditions of partial occultation by each of the three occulting blades; the degrees and direction of blade movement to be determined by the testing supervisor.	h. Rotate the corresponding test resolvers in the required direction and to the dial reading necessary to accomplish the commanded partial occultation.	h. The occulting blades will move to produce the commanded partial occultation to ±3° degrees accuracy relative to the reticle's fiducial marks.
Sunshafting Effect		
a. Simulate the gradual entrance of sun rays into the Telescope's optical path.	a. Slowly turn the rheostat on the Power Control Panel in Unit No. 9 labeled SUNSHAFTING INTENSITY (TELESCOPE portion of the panel) in the clockwise direction from the limit stop for CCW rotation to the limit stop for CW rotation.	a. The effect, as seen on the reticle, will be the entrance and gradually increasing intensity of non-image forming light into the optical path of the Telescope. Maximum brightness will be that supplied by one 21-candle power lamp.
b. Simulate re-orientation of the Telescope shaft and/or trunnion axes to eliminate the sunshafting effect.	b. Rotate the rheostat counterclockwise back to the CCW rotation limit stop.	b. The sunshafting effect will gradually diminish until completely eliminated.

2-53. SEXTANT EQUIPMENT.

2-54. Following the functional testing of the electrical and electronic components in the sextant/telescope electronics cabinet, the functional tests of the telescope and sextant are performed. The tests serve two purposes:

a. To verify the correct operation of the opto-electro-mechanical assemblies in the instrument.

b. To establish the true orientation of the optical paths; meaning that there has been no displacement of a fixed optical element since termination of the last operating period.

2-55. Manpower and Equipment Requirements. Three technicians are required to perform the functional tests. An optical technician, skilled and experienced as noted above, is stationed at the eyepiece of the sextant inside the command module, an experienced electronic technician is stationed at the test panel of the electronics cabinet (unit No. 9), and a third technician is stationed near the carousel to operate the pushbutton switches on the slide actuation electronics unit. The optical technician is the chief of the functional testing team, and is the one who gives the "commands" for the procedures listed in the succeeding paragraphs.

NOTE

> It is important that the technicians performing the functional tests be highly skilled in their respective crafts. This is particularly necessary with reference to the optical technician taking the required readings through the eyepiece of the command module.

2-56. Equipment requirements for functional testing are limited to intercommunication telephone headsets for voice communication between the technicians.

2-57. Pre-Test Conditions. The following conditions must exist at the beginning of the sextant functional testing:

a. The primary power cables to the electronics cabinet (unit No. 9) must be connected and energized.

b. Refer to electronics test panel control function tables; the following toggle switches must be placed in the "TEST" position for the following sections of the test panel:

1. SEXTANT STARFIELD ROTATION SERVO
2. SEXTANT RETICLE SERVO

3. SEXTANT ROTATING PRISM SERVO
4. SEXTANT POLARIZER SERVO
5. SEXTANT VARIABLE MAGNIFIER SERVO
6. SEXTANT STARFIELD SCANNER SERVO
7. SEXTANT STARFIELD SCANNER SERVO
8. SEXTANT LANDMARK SCANNER SERVO
9. SEXTANT LANDMARK SCANNER SERVO
10. SEXTANT SLIDE SELECTOR
11. SEXTANT STARFIELD SELECTOR (the toggle switch labeled EVEN/ODD on the right side of this panel section must be set at the "ODD" position.

c. The dials, indicating test resolver rotor angle, in panel sections one through nine, above, must read zero degree.

d. In the **SEXTANT SLIDE SELECTOR** panel section both the "tens" and "units" rotary switches must be at the "0" position to inject the test pattern slide into the slide gate. In the **SEXTANT STARFIELD SELECTOR** section the rotary switch must be set at the "1-2" position. This setting will present Star Group 2 (see figure 2-65 and table 2-70) when the Starfield Line of Sight is illuminated.

e. Refer to table 2-6 for control function of the power control panel. The three pole circuit breaker for 60-cycle, 3-phase, 120-volt d-c power must be on, and the three indicator lights, one for each phase, illuminated.

f. The toggle switch in the 400-cycle, single-phase, 120-volt a-c circuitry must be in the "ON" position, and the indicator light above the 3-ampere fuse illuminated.

g. The rheostat knob labeled **SUNSHAFTING INTENSITY**, on the **SEXTANT** side of the panel must be turned counterclockwise to its limit stop. The toggle switch, located on the rear of the power control chassis, labeled **SUNSHAFTING** must be in the "TEST" position. Access to this switch is gained through the rear doors of the electronics cabinet.

h. The rheostat knob labeled **RETICLE INTENSITY** must be turned fully clockwise.

i. The rheostat knob labeled **STARFIELD INTENSITY** must be turned fully clockwise. This will provide maximum starfield LOS illumination.

j. The toggle switch located inside the landmark light source section of the combined light source housing must be set to the "TEST" position. This will provide maximum illumination of the Landmark LOS.

NOTE

When the functional testing is started the observer at the sextant eyepiece can adjust the diopter setting of the eyepiece to provide the best focus.

2-58. Landmark Test Slide. (See figure 2-64.) With the condition established in paragraph 2-56, above, the landmark test slide will be injected into the slide gate. An explanation of the markings on the test slide pattern, and the manner in which these markings are used, in conjunction with the sextant rotating reticle engraving (see figure 2-65) is contained in the paragraphs to follow.

NOTE

For the purpose of illustration, see figure 2-64, the landmark test pattern is shown as having black lines on a white (or clear) background. The actual test pattern slide in the carousel slide magazine is opaque with clear, or transparent, markings. Correspondingly, the engraved reticle is clear with white opaque markings; therefore figure 2-65 sextant rotating reticle engraving, is a true representation of the actual reticle in the sextant. These facts must be borne in mind while reading the following explanation of the test pattern slide markings and there relationship to the reticle engraving.

2-59. Test Pattern Markings and Rotating Reticle Engraving. The functional testing purposes of the test pattern markings with relationship to the reticle engravings are as follows:

a. The horizontal X axis and the vertical Y axis of the test pattern correspond to the X and Y axes of the reticle. When the operable assemblies in the landmark line of sight are zeroed and the rotating reticle oriented so that the X axis is horizontal and the Y axis vertical, the parallel lines of the +X side and the parallel lines on the -Y side of the reticle should straddle the single +X and -Y axes of the test pattern, respectively. The straddling should be such that the single lines of the test pattern will appear in the central portion of the space between the reticle parallels.

b. The eight sets of radial single and parallel lines (two sets in each quadrant), and the parallel lines along the + and -X and Y axes of the test pattern are located at 30 degree intervals. They are used to check both the runout and positioning accuracy of the rotating reticle, as well as the landmark image rotation capability of the rotating prism.

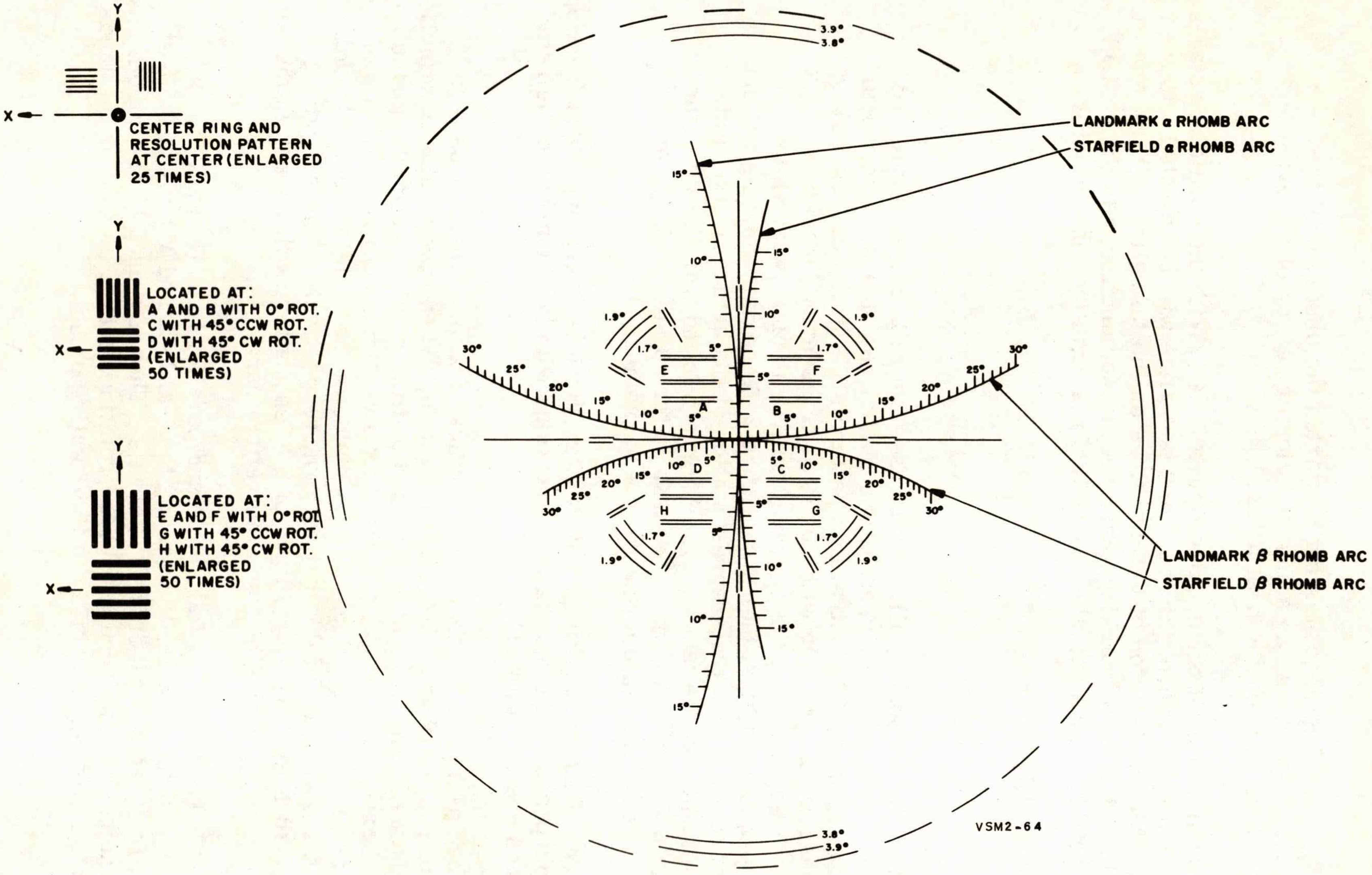


Figure 2-64. Landmark Test Pattern

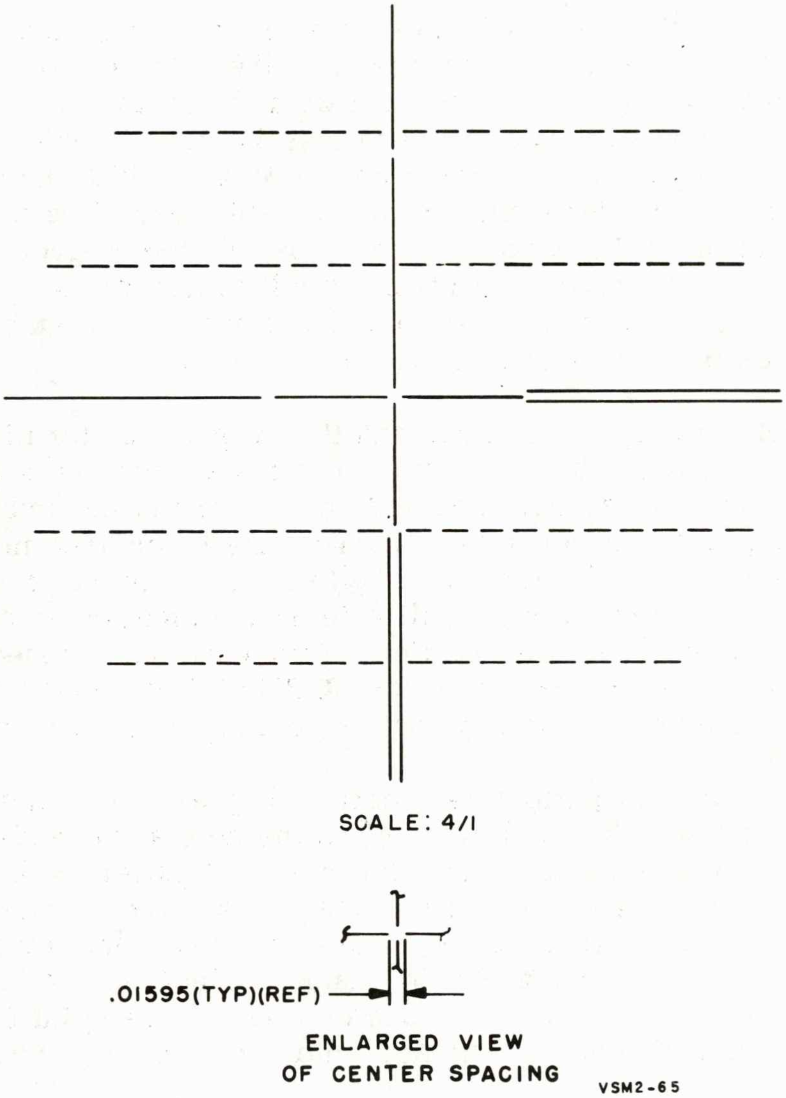


Figure 2-65. Sextant Rotating Reticle Engraving

c. The 12 sets of parallel lines (3 in each quadrant parallel to the X axis of the pattern) are used in conjunction with the inner pair of broken lines parallel to the X axis of the reticle to test the variable magnification assembly. With the lens halves of the assembly positioned for unity (1:1) magnification, the center parallels of each set on the test pattern should appear to straddle the inner parallels on the reticle. With maximum ($\sqrt{2}$) magnification, the inner parallels of the pattern should straddle the inner parallels on the reticle, and conversely, at minimum magnification, or maximum reduction, ($1/\sqrt{2}$) the outer parallels of each set on the pattern should straddle the inner parallels on the reticle. In each of the above conditions the straddling should be such that the inner dashed parallels of the reticle appear to lie in the central portion of the area between the parallels on the test pattern.

d. The four sets of three curved lines, one set in each quadrant, with the inner curve of each set marked 1.7 degrees and the outer curve marked 1.9 degrees, are used to verify the required 1.8 degrees on-axis field of view of the sextant. These curves are also used to test the permissible image deflection introduced by rotation of the rotating prism. With the centers of the test pattern and reticle indexed, and the variable magnification set for 1:1 magnification, rotation of the rotating prism through 360 degrees will cause the image of the test pattern and the reticle itself to appear to rotate through 720 degrees. During this double rotation at least one line of each of the four sets of curved lines must be visible in the field of view.

e. The four sets of two curved lines and the dashed line forming the periphery of the test pattern are reference marks defining the conical angularity of the landmark scenes mounted on each of the landmark slides. As shown in the upper and lower sets of curves, the inner arcs indicate 3.8 degrees and the next arcs 3.9 degrees. The broken circle marking the periphery of the pattern represents the full 4 degree conical angle of the landmark scene over which the 1.8 degree field of view can be scanned at minimum magnification when the sextant is "IN NORMAL" (computer controlled) operation. The arcs do not serve any purpose during functional testing.

f. The center of the test pattern is illustrated, greatly enlarged, in the upper left corner of figure 2-64. Referring to the note at the end of paragraph 2-57, it must be remembered that the real test pattern will be seen as having an opaque circle surrounded by a clear area. The diameter of the black, or opaque, circle is 0.003 ±0.004 inches, and the diameter of the clear area surrounding the central dot is 0.0066 ±0.0004 inches. During functional testing, the opaque circle is used as a reference point for zeroing the several operable assemblies. The procedure for zeroing is as follows:

1. With the variable magnification set for 1:1 and the landmark line of sight illuminated, zero position for the rotating reticle is indicated when the X and Y axes of the reticle and the test pattern are seen as indexed (see subparagraph a. above), and an estimated inward extension of the reticle axes appear to intersect within the 0.003 inch diameter area of the opaque center.

2. The above condition will exist only when the α and β rhomboids of the landmark rhomb scanner are zeroed and when the rotating polaroid filter, as well as the rotating prism, are zeroed, providing maximum illumination and vertical orientation of the test pattern.

3. With both landmark and starfield lines of sight illuminated, the navigational star of the star group presented in the starfield optical path, when the α and β rhomboids of the starfield rhomb scanner are zeroed, must be seen within the opaque circle at the center of the test pattern.

In addition to serving as a reference for zeroing the operable components, the opaque center circle and the clear circle surrounding it are used to check repeatability accuracy of the carousel rotation and landmark slide positioning in the slide gate. Observed in conjunction with a navigational star, the opaque and clear circles at the center of the test pattern also servo to check the amount, if any, of landmark line of sight displacement introduced by running the variable magnification from maximum to minimum, and any displacement introduced by rotation of the rotating polaroid filter.

g. The resolution patterns, also shown greatly enlarged in figure 2-64, with accompanying legends regarding their location and orientation on the test pattern, serve in functional testing to prove the resolving power of the sextant's optical system. With the landmark line of sight illuminated, the test pattern properly positioned in the slide gate, the variable magnification set for 1:1 magnification, and the landmark rhomb scanner and rotating polaroid filter zeroed, all of the resolution patterns must be clearly distinguishable in the on-axis field of view.

NOTE

> It has been established in acceptance testing that the above stated condition does exist. In functional testing, the ability of the observer (technician) at the sextant's eyepiece to clearly resolve the resolution pattern near the center of the test pattern will depend upon his acuity of vision.

h. The landmark and starfield α and β rhomb arcs, identified by callouts on figure 2-64, are used to checkout the proper functioning of the two rhomb scanning assemblies in the sextant, one in the landmark L.O.S. and the other in the starfield L.O.S. In testing the landmark rhomb scanner, rotation of the mirror rhomboid (α rhomb) will cause the test pattern to appear to move up and down across the reticle; rotation of the prism rhomboid (β rhomb) will cause the pattern to appear to move back and forth horizontally across the reticle. With variable magnification of 1:1, the curved lines tangential to the Y and X axes, appear to move across the center of the reticle, depending upon which of the two-speed directors on the electronics cabinet test panel is operated. In testing the starfield rhomb scanner, rotation of the mirror rhomboid (α rhomb) will cause the navigational star in the star group presented in the starfield optical path to appear to move up and down along the starfield rhomb arc; rotation of the prism rhomboid (βrhomb) will cause the navigational star to track along the starfield rhomb arc. As described in paragraphs 1-263 and 1-264 and illustrated in figure 1-55, conjunctive rotation of both rhomboids permits scanning the 1.8 degree field of view over the much larger area of the scenes presented in each optical path. However, it must be noted that only with the variable magnification set at $1/\sqrt{2}$, or maximum reduction, that the scanning of the largest area of the scene is possible. During functional testing procedures, the tests of the rhomb scanners is performed with variable magnification set at 1:1, or

unit magnification. Table 2-70 was made up for information purposes, primarily to indicate to the technician at the electronics cabinet test panel the amount of rotation of the 32X test resolvers necessary to produce the simulated movement of (1) the test pattern, for landmark rhomb scanner testing, and (2) the apparent movement of the navigational star along the arcs identified as α starfield rhomb arc and β starfield rhomb arc. It will be noted that the α and β rhomb arcs for landmark and starfield are different in length, although each corresponding arc is graduated in the same number of degrees, marked at intervals of five degrees. This difference is due to the difference in physical size of the corresponding rhomboids in each of the two rhomb scanning assemblies, which is accounted for by the difference in diameters of the starfield scene and the landmark scene presented for viewing.

NOTE

In using table 2-70, it should be noted that for all numbers in the four columns, except the numbers preceding the plus symbol (+) in column two, the degree symbol (^{o}) is to be understood.

Table 2-70. Landmark and Starfield Rhomb Scanning Data

Landmark α Arc Landmark β Arc Starfield α Arc Starfield β Arc Degree Marks	32X Test Resolver Rotation of Each α and β Servo	32X Resolver Dial Reading	1X Resolver Dial Reading
0*	0	0	0
+ 1	0 + 192 CW	192	6
+ 2	1 + 24 CW	24	12
+ 3	1 + 216 CW	216	18
+ 4**	2 + 48 CW	48	24
+ 5***	2 + 240 CW	240	30
+ 6	3 + 72 CW	72	36
+ 7****	3 + 264 CW	264	42
+ 8	4 + 96 CW	96	48
+ 9	4 + 288 CW	288	54
+ 10*****	5 + 120 CW	120	60
+ 11	5 + 312 CW	312	66
+ 12	6 + 144 CW	144	72
+ 13	6 + 336 CW	336	78
+ 14	7 + 168 CW	168	84
+ 15	8 CW	0	90
- 1	0 + 192 CCW	168	354
- 2	1 + 24 CCW	336	348
- 3	1 + 216 CCW	144	342
- 4**	2 + 48 CCW	312	336
- 5***	2 + 240 CCW	120	330
- 6	3 + 72 CCW	288	324
- 7****	3 + 264 CCW	96	318
- 8	4 + 96 CCW	264	312
- 9	4 + 288 CCW	72	306
- 10*****	5 + 120 CCW	240	300
- 11	5 + 312 CCW	48	294
- 12	6 + 144 CCW	216	288
- 13	6 + 336 CCW	24	282
- 14	7 + 168 CCW	192	276
- 15	8 CCW	0	270

*0 position is when the centers of the Test Pattern and the reticle are indexed.

** The Navigational Star must remain on the Starfield α Rhomb Arc within ±3.5° of Starfield α Rhomb scan.

*** The Landmark α Rhomb Arc must remain centered on the reticle within ±5° of Landmark α Rhomb scan.

**** The Navigational Star must remain in coincidence with the Starfield β Rhomb Arc within ±7° of Starfield β Rhomb Scan.

***** The Landmark β Rhomb Arc must remain centered on the reticle within ±10° of Landmark β Rhomb scan.

Table 2-70. Landmark and Starfield Rhomb Scanning Data (Cont'd)

Landmark β Arc Starfield β Arc Degree Marks	32X Test Resolver Rotation of Each β Servo	32X Resolver Dial Reading	1X Resolver Dial Reading
+16	8 + 192 CW	192	96
+17	9 + 24 CW	24	102
+18	9 + 216 CW	216	108
+19	10 + 48 CW	48	114
+20	10 + 240 CW	240	120
+21	11 + 72 CW	72	126
+22	11 + 264 CW	264	132
+23	12 + 96 CW	96	138
+24	12 + 288 CW	288	144
+25	13 + 120 CW	120	150
+26	13 + 312 CW	312	156
+27	14 + 144 CW	144	162
+28	14 + 366 CW	336	168
+29	15 + 168 CW	168	174
+30	16 CW	0	180
-16	8 + 192 CCW	168	264
-17	9 + 24 CCW	336	258
-18	9 + 216 CCW	144	252
-19	10 + 48 CCW	312	246
-20	10 + 240 CCW	120	240
-21	11 + 72 CCW	288	234
-22	11 + 264 CCW	96	228
-23	12 + 96 CCW	264	222
-24	12 + 288 CCW	72	216
-25	13 + 120 CCW	240	210
-26	13 + 312 CCW	48	204
-27	14 + 144 CCW	216	198
-28	14 + 336 CCW	24	192
-29	15 + 168 CCW	192	186
-30	16 CCW	0	180

NOTE

With respect to the Landmark α and β Rhomb Scanners, it should be remembered that rotation of the 32X resolvers in the directions indicated in the table will cause the image of the Test Pattern on the reticle to move in the + or - direction, as shown in Column 1, however the degree marks of opposite sign will be seen on the center of the reticle.

2-60. Testing Procedure. The objectives of functional testing, as stated in paragraph 2-33, will be most efficiently accomplished by following the sequence as listed in table 2-71. In certain testing procedures, a deviation from the required results, as stated in the third column of table 2-71, may be within allowable limits of error and not necessarily an indication of malfunctioning. This applies to (1) landmark slide positioning repeatability, (2) image positioning error introduced by the variable magnification, and (3) image positioning error introduced by the rotating polaroid. In these cases the determination as to whether the error is within allowable limits is made by performing mathematical computations to obtain the root mean square (RMS) of error, after converting resolver dial degree readings to linear values by applying certain scale factors. The scale factors for the landmark and starfield rhomb scanners are as follows:

(Displacement corresponding to 1 degree on 32X Test Panel Dial at magnification of 1:1.)

Landmark α Rhomb Servo - on Y Axis = 0.00043 in.
Landmark β Rhomb Servo - on X Axis = 0.00026 in.
Starfield α Rhomb Servo - on Y Axis = 0.00030 in.
Starfield β Rhomb Servo - on X Axis = 0.00016 in.

2-61. The methods and computations for determining whether a deviation from the exact "required result" for certain of the functional tests are given in the following paragraphs, which are referred to by paragraph number in the third column of table 2-71, where applicable.

2-62. Landmark Slide Positioning Repeatability. If the navigational star is not centered within the opaque central ring of the test pattern, proceed as follows:

a. Adjust the α and β starfield rhomb scanners as necessary to bring the navigational star to the center of the opaque ring. Record the 32X resolver dial readings for both two-speed test directors, and then square the readings and record the squares.

b. Operate the "tens" and "units" rotary switches of the SEXTANT SLIDE SELECTOR to select any other slide; wait five seconds and then return the switches to 0 and 0 to re-inject the test pattern slide.

c. Observe the position of the navigational star with respect to the central opaque ring of the test pattern. If the star is not seen in the center of the ring, again adjust the starfield rhomb scanner; record the 32X resolver dial reading, square the readings and record the squares under the numbers obtained in "a.", above.

d. Repeat "b." and "c." until five 32X resolver dial readings, and the squares thereof, for both the α and β rhomb drives have been recorded.

e. Add each column of squares, divide the sums by 5, and convert the quotients so obtained to linear dimensions by multiplying the α quotient by 0.00030, and the β quotient by 0.00016.

f. Add the products of the linear conversions and extract the square root of the sum to obtain the RMS of linear displacement error. The RMS of linear displacement error must not exceed 0.0005 in.

2-63. Landmark LOS Displacement Introduced by Variable Magnification. If the landmark test pattern appears to move so that the navigational star is decentered when the variable magnification is driven from 1:1 magnification to minimum magnification and from 1:1 magnification to maximum magnification, measure the amount of displacement as follows:

a. Set the variable magnification test resolver for a dial reading of 72.6 degrees to produce minimum magnification (0.707).

b. Adjust the α and β landmark rhombs to center the navigational star on the test pattern central opaque ring; record the number of 32X resolver rotations for each rhomb required to accomplish the centering.

c. Multiply the number of α rhomb 32X resolver rotations by 0.00043, and multiply the number of β rhomb 32X resolver rotations by 0.00026 and record the product of each multiplication.

d. Square the two products obtained in "c" above, add the squares and extract the square root of the sum.

e. Set the variable magnification test resolver for a dial reading of 255.8 degrees to produce maximum magnification (1.4.4).

f. Repeat procedures "b" through "d" to obtain linear displacement error at maximum magnification.

g. If maximum displacement of the test pattern central ring with respect to the navigational star is observed at some magnification value between minimum and maximum, repeat procedures "b" through "d" with the variable magnification test resolver set for that dial reading.

The RMS of misalignment of the landmark LOS at minimum, maximum, or any magnification value in between; i.e., the linear dimensions obtained in "d", "f", and "g", above must be less than 0.0021 inches.

2-64. Image Deflection Introduced by the Rotating Polaroid. If the navigational star does not appear exactly centered on the opaque central ring of the test pattern, with all assemblies zeroed, but is within allowable limits of off-axis, i.e., is observed somewhere within the area defined by the diameter

of the opaque ring, an apparent circular motion of the opaque ring will be introduced by rotation of the rotating polaroid filter through 360 degrees. Measure the amount of the deflection caused by the rotating polaroid as follows:

a. Rotate the rotating polarizer servo to where the displacement of the opaque central ring, with reference to the navigational star, appears to be the greatest in the X axis direction.

b. Using the landmark α rhomb scanner 32X test resolver, perform the apparent movement of the test pattern so that the Y axis of the pattern is in coincidence with the navigational star.

c. Record the number of degree marks from 0 on the 32X test resolver dial. If the rotation has been in the increasing order, record the number as plus (+); if in the decreasing order, record the number as minus (-).

d. Rotate the rotating polarizer servo to where the displacement of the opaque central ring of the test pattern, with reference to the navigational star, appears to be least in the X axis direction.

e. Repeat "b" and "c".

f. Add the recorded numbers if of opposite sign or subtract the numbers if of the same sign. Divide the result by 2 and multiply the quotient by the scale factor 0.00026 to obtain the linear displacement, which must be less than 0.0005 inc. As a check, compute the linear displacement in the Y axis direction. In the check, the β landmark rhomb scanner is used to bring the X axis of the test pattern into coincidence with the navigational star from the greatest and the least apparent deflections. The scale factor of 0.00043 is used as the multiplier to obtain the linear displacement in inches. The linear displacement obtained in "f" and the linear displacement obtained in the check should not differ by more than 0.0001 in.

2-65. If the computations for linear displacements obtained in paragraph 2-64 exceed the allowable limits, compute the RMS of linear displacement as follows:

a. Compute the linear displacement in both X and Y axes directions five times.

b. Add the results of each set of computations, divide each sum by five, and extract the square root of the quotients.

The RMS obtained in "b" must not exceed 0.0006 inch, and the two RMS must not differ by more than 0.0001 inch.

2-66. The functional tests for the sextant are presented in tabular form in table 2-71. Before starting the tests, recheck that all pre-test conditions listed in paragraph 2-57 are established.

Table 2-71. Sextant Functional Tests

Commands	Procedures	Required Results
Zero Alignment of Landmark and Starfield LOS		
No command required. The establishment pretest conditions, see paragraph 2-25, presents both LOS illuminated and all operable assemblies zeroed.	No procedures required.	The Test Pattern should appear focused on the reticle. The observer can adjust the focus at the eyepiece for best visibility. The X and Y axes of Test Pattern and reticle should be indexed, as indicated by the +X and -Y axes of the pattern appearing in the central half of the space between the corresponding parallel lines of the reticle axes. The opaque central ring of the Test Pattern should be seen centered in the opening between the reticle's axes, and the Navigational Star of Star Group No. 1 should be seen exactly centered, or nearly so within the opaque ring.
Landmark Slide Positioning Repeatability		
Command the selection of Landmark Slide No. 5 and then, after an interval of five seconds, the return to Test Pattern Slide.	Turn the "units" rotary switch of the LANDMARK SLIDE SELECTOR on the Test Panel to 5 and, after the commanded five second interval, turn the switch back to 0.	The observer should see the Required Result for Zero Alignment, described above. If the result is negative, refer to paragraph 2-63 and compute the RMS of linear displacement. If the RMS exceeds the allowable limit of error, a malfunction of the slide injection mechanism is indicated.
Landmark α Rhomb Scanner Alignment and Positioning		
With zero alignment established (Required Result No. 1 above) command α Landmark Rhomb Scanning to bring the -14° mark on the Test Pattern's Landmark α Rhomb Arc to the center of the reticle, and then return to 0.	Refer to Table 2-70 Rotate the 32X test resolver of the α Rhomb 2-speed director through 7 revolutions plus 168° (the 32X dial should read 168° and the 1X dial 84°) then, after a three second pause, rotate the 32X resolver in the opposite direction until both dials read 0.	The observer should see the Test Pattern appear to move upward with the -Y portion of the Landmark α Rhomb Arc remaining approximately centered on the reticle until the -14° mark on the Arc can be seen at the reticle center. During this apparent movement the Navigational Star must be seen within the arc line width for at least .5° of the travel. After a three second pause at the limit of scan, the Test Pattern will appear to move downward until the zero alignment is again established.
Command α Landmark Rhomb Scanning to bring the +14° mark on the Landmark α Rhomb Arc to the center of the reticle, and then return to 0.	Rotate the 32X test resolver in the opposite direction, counterclockwise, through 7 revolutions plus 168° (the 32X dial should read 276° and the 1X dial 192°), pause three seconds and rotate the 32X resolver in the opposite direction, clockwise, until both dials read 0.	The Test Pattern should appear to move downward with the +Y portion of the Landmark α Rhomb Arc remaining approximately centered on the reticle until the +14° mark can be seen at the reticle center. The Navigational Star should be seen within the line width of the arc through at least 5° of movement. After the three second pause, the Test Pattern will move upward until the zero alignment is reestablished.

Table 2-71. Sextant Functional Tests (Cont)

Commands	Procedures	Required Results
Landmark β Rhomb Scanner Alignment and Positioning		
With zero alignment established, command Landmark β Rhomb Scanning to bring the -29° mark on the pattern's Landmark β Rhomb Arc to the center of the reticle, and then return to 0.	Refer to Table 2-70. Rotate the 32X test resolver through 15 revolutions plus 168° clockwise (32X dial reading 168° and 1X dial reading 174°). Then, after a three second pause, rotate the 32X resolver counterclockwise until both dials read 0.	The observer should see the Test Pattern appear to move to the right with the -X portion of the Landmark β Rhomb Arc remaining approximately centered on the center of the reticle until the -29° mark appears on the reticle. The Navigational Star should remain within the line width of the arc through 10° of travel. After a three second pause the pattern should be seen to move to the left until zero alignment is reestablished.
Command β Rhomb Scanning to bring the +29° mark on the Landmark β Rhomb Arc to the center of the reticle and then return to 0. NOTE Failure to achieve the required results on the first attempt does not necessarily indicate a malfunction of the Rhomb Scanner Assembly. Repeat the particular test that appears to produce negative results two or three times to assure the elimination of human failure. If, after three repetitions, the required results are not achieved, an electrical or mechanical malfunction of the Landmark Scanner Assembly is indicated.	Rotate the 32X test resolver through 15 revolutions plus 168° counterclockwise (32X dial reading 168° and 1X dial reading 186°), pause three seconds and rotate the 32X resolver clockwise until both dials read 0.	The Test Pattern should appear to move to the left with the +X portion of the Landmark β Rhomb Arc remaining approximately centered on the reticle until the +29° mark appears on the reticle. The Navigational Star should be seen within the line width of the arc through 10° of movement. After a three second pause the pattern should be seen as moving to the right until zero alignment is again reestablished.
Variable Magnification Alignment and Magnification		
Command test operation of the Variable Magnification Assembly to produce minimum magnification (0.707), or maximum reduction, and then returned to 1:1 or unity magnification.	The Sextant Variable Magnification Servo Resolver on the Test Panel is rotated from 0 to 72.6°, and then after a three second pause returned to 0.	The observer should see the Navigational Star remain centered within the opaque central ring of the Test Pattern throughout the apparent recession of the pattern; at the termination of apparent movement, the inner set of dashed lines on the reticle should appear approximately centered between the outer pair of parallels on the Test Pattern. After the three second pause at the limit of reduction the Test Pattern should appear to move toward the observer until the inner dashed lines of the reticle are again seen in the central portion of the space between the middle set of Test Pattern parallels. The Navigational Star must remain within the central opaque ring of the Test Pattern.

Table 2-71. Sextant Functional Tests (Cont)

Commands	Procedures	Required Results
Command operation of the Variable Magnification to produce maximum magnification (1.414), and then return to unity magnification. NOTE Refer to paragraph 2-62 for instructions on computing the RMS of alignment error if the opaque central ring of the Test Pattern appears to move in a circle, with respect to the Navigational Star, during the above tests.	Rotate the test resolver to a dial reading of 255.8°; after a three second pause, reverse the rotation to 0.	The Test Pattern should appear to move toward the eye of the observer until the inner pair of dashed lines on the reticle are seen approximately centered between the inner pair of parallel lines of the Test Pattern. Following the stabilization pause, the pattern should appear to recede until the inner pair of reticle lines are again centered between the middle pair of parallels on the pattern. As is the case with minimum magnification, the Navigational Star must remain within the opaque central ring of the Test Pattern throughout the test.
<u>Rotating Polaroid Filter</u>		
Command rotation of the Rotating Polaroid through 360°. NOTE Refer to paragraph 2-63 for instructions on computing the RMS of deflection, if not zero.	Rotate the Sextant Polarizer Servo slowly and as smoothly as possible through 360°.	The observer at the eyepiece must manually adjust the polaroid analyzer to maintain good visibility of the Test Pattern during the polaroid filter rotation. There should be no apparent movement of the opaque central ring of the pattern with relationship to the Navigational Star during 360° rotation of the filter.
<u>Star Group Selection</u>		
Command that the Landmark Light Source be turned off.	The technician stationed near the Sextant's Carousel opens the hinged cover of the Landmark Light Source and moves the toggle switch to NORM.	The observer sees only the Starfield optical path illuminated with Star Group No. 1, α Andromedae, presented.
Refer to Table 1-28 and Figure 2-66, composing the presentation of Star Group No. 8, α Tauri. NOTE Table 1-28 indicates that correct orientation of Star Group No. 8 requires 26° CW rotation of the Starfield.	The technician at the Test Panel turns the Sextant Starfield Selector rotary switch to position 7-8, leaving the ODD/EVEN toggle switch at ODD.	The observer will see the Navitational Star α Tauri center of the opening between the X and Y axes of the reticle.
Command 26° clockwise rotation of the Star Group.	Technician rotates Starfield Rotation test resolver to a dial reading of 26°.	The observer will see the Navigational Star and the surrounding stars visible in the Field of View rotate 26° in the clockwise direction. No occultation of surrounding stars should be seen during the rotation.

Table 2-71. Sextant Functional Tests (Cont)

Commands	Procedures	Required Results
Command presentation of Star Group No. 19, α Bootis, with zero rotation of the Starfield.	The Starfield Rotation Servo is returned to 0 dial reading, the toggle switch of the Starfield Selector is set to EVEN, and the rotary switch is turned to position 15-16.	The observer should first see the Starfield rotate 12° in the counterclockwise direction and then, after the rotation of the Star Mask, Star Group 19 should be seen as indicated in Figure 2-66. NOTE The surrounding stars are NOT circled on the real Starfield disc; they are shown as circled in Figure 2-66 so that spurious marks, picked up in the ozalid reproduction process, are not mistaken for stars.
Starfield Rotation		
Command presentation of Star Group No. 7, α Persei, with zero scan.	The Starfield Selector toggle switch is left at EVEN and the rotary switch is turned to position 5-6. Check to see that all dials in the Starfield α and β Rhomb Scanner two-speed directors are zeroed.	The observer will see Star Group No. 7 as represented in Figure 8-1. However, with the Starfield Rhomb Scanner zeroed, six of the eight surrounding stars will be visible in the 1.8° Field of View; the two stars (one at 2:30 o'clock and the other at 7:00 o'clock) cannot be seen.
Command 360° rotation of the Starfield scene.	The Starfield Rotation Servo is turned slowly and smoothly through 360°.	The observer will see the starfield image turn 360° about the Navigational Star. The Navigational Star will remain centered on the reticle, and there will be no occultation of the surrounding stars during the rotation.
Starfield α Rhomb Scanner Alignment and Positioning		
With Star Group No. 7 presented in the starfield optical LOS, command re-illumination of the Landmark optical path, and presentation of the Test Pattern.	The technician stationed at the Sextant opens the Landmark Light Source compartment and turns the toggle switch to TEST position. The technician at the Test Panel checks to see that the "tens" and "units" rotary switches for Sextant Slide Selector are both turned to 0.	The observer will see the Landmark Test Pattern and Star Group No. 7 superimposed on the reticle, with the Navigational Star visible within the opaque central ring of the pattern.
If necessary, command adjustment of the Landmark α and β Rhomb Scanners to bring the Navigational Star to the exact center of the opaque central ring on the Test Pattern.	The technician at the Test Panel, following voice instructions from the observer at the eyepiece, will rotate the 32X test resolvers of the Landmark α and β Rhomb Scanners until the required centering of the Star is achieved.	The observer will see the Test Pattern appear to move until the Navigational Star is exactly centered in the opaque central ring.

Table 2-71. Sextant Functional Tests (Cont)

Commands	Procedures	Required Results
Command the α Starfield Rhomb scanning through +14° along the Starfield α Rhomb Arc, and then return to 0.	The 32X test resolver of the Starfield α Rhomb 2-speed director is turned clockwise through 7 revolutions plus 168°; 32X dial reads 168°, 1X dial reads 84°. Following a three second pause rotation of the 32X resolver is reversed until both dials again read 0.	The Test Pattern will appear to remain stationary while the Navigational Star moves upward, following the curve of the +X portion of the Starfield Rhomb Arc. The Star must remain within the line width of the arc through at least +3-1/2° of travel. Following the pause, the Star will return to 0.
Command α Starfield Rhomb scanning through -14° along the Starfield Rhomb Arc, and return to 0.	The 32X Starfield α Rhomb test resolver is turned counterclockwise through 7 revolutions plus 168°; 32X dial reads 192°, 1X dial reads 276°. After a three second pause, reverse the rotation of the 32X resolver until both dials read 0.	The Navigational Star will be seen to move along the -X portion of the Starfield α Rhomb Arc through -14°. The Star must be seen within the line width of the arc through -3-1/2° of movement. Following the stabilization pause, the Star will move upward until again centered in the opaque central ring of the Test Pattern.
Starfield β Rhomb Scanner Alignment and Positioning		
Command β Starfield Rhomb scanning through +29° along the Starfield β Rhomb Arc, and return to 0.	Rotate the 32X Starfield β Rhomb test resolver clockwise through 15 revolutions plus 168°; 32X dial reads 168°, 1X dial reads 174°. After a three second pause, reverse rotation of the 32X resolver until both dials read 0.	The Navigational Star will be seen to move along the Starfield β Rhomb Arc in the +Y direction until the +29° mark is reached. The Star must remain within the line width of the arc through the first 7° of movement. After three second pause, the Star will be seen to move back along the arc until again centered in the opaque central ring of the Test Pattern.
Command β Starfield Rhomb scanning through -29° along the Starfield β Rhomb Arc, and return to 0. NOTE The NOTE following the functional tests of the Landmark α and β Rhomb Scanners applies as well to the Starfield Rhomb Scanners.	Rotate the 32X β Rhomb test resolver counterclockwise through 15 revolutions plus 168°; 32X dial reads 192°, 1X dial reads 186°. After a three second pause, reverse rotation of the 32X resolver until both dials read 0.	The Navigational Star will be seen to move in the -Y direction to the -29° mark on the Starfield Rhomb Arc. The Star must remain within the line width of the arc during the first 7° of movement. After the three second pause the Star will move back along the arc until again centered in the opaque ring on the Test Pattern.
Rotating Reticle Rotation and Positioning		
Command the Starfield Light Source to be turned off.	The rheostat knob on the Power Control Panel labeled STARFIELD INTENSITY is turned counterclockwise against its limit stop.	The observer will see only the Landmark LOS illuminated with the Landmark Test Pattern focussed on the reticle.

Table 2-71. Sextant Functional Tests (Cont)

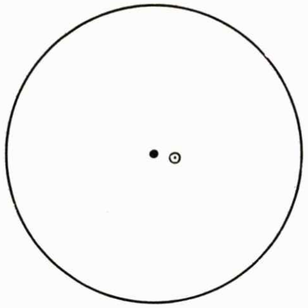
Commands	Procedures	Required Results
If necessary, command adjustment of the Landmark α and β Rhomb Scanners to cause the apparent movement of the Test Pattern so that the X and Y axes of both reticle and Test Pattern are in exact coincidence.	Following voice instructions from the observer at the eyepiece, the technician at the Test Panel rotates the 32X test resolvers of the Landmark α and β Rhomb Scanners to achieve the required coincidence of the axes.	The observer will see an apparent movement of the Test Pattern that will bring the opaque central to the exact center of the opening between the reticle's X and Y axes, and the single line +Y and -X axes of the reticle will be seen within the central half of the space between the parallels along the corresponding axes of the pattern; for perfect positioning, there should be no visible distinction between the X and Y axes of the Test Pattern with respect to the X and Y axes of the reticle.
Command reticle rotation through 360° in increments of 30°. The observer should indicate by voice instruction to the technician at the Test Panel when to rotate the test resolver to the next position.	Following instructions from the observer, the Sextant Reticle Servo resolver is rotated through 360° in 30° increments. Care must be exercised to assure that the dial readings are exactly 30° apart at each stop in rotation.	The observer should see the reticle rotate with reference to the Test Pattern so that, at each 30° increment of rotation, the single radial line of the Test Pattern is straddled by the parallel lines extending beyond the single +X and -Y axes of the reticle, and correspondingly at 180° from the above described position, the single +Y and -X axes of the reticle are straddled by the parallels of the Test Pattern. At each position the straddling should be such that the single lines are seen within the central half of the area between the parallels.
Rotating Prism Rotation and Positioning		
Following 360° rotation of the reticle, the Test Pattern should be seen correctly indexed on the plane of the reticle, with the Y axes of pattern and reticle coinciding and vertical, and the X axes coinciding and horizontal. Command 360° rotation of the Rotating Prism in increments of 30°. As with the reticle test, the observer will instruct the technician at the Test Panel when to rotate the test resolver to the next position.	Following instructions from the observer, the Sextant Rotating Prism Servo resolver is rotated in 30° increments through 360°. Again, care must be exercised to assure exact dial readings at each stop in rotation.	For each 30° rotation of the prism, the reticle and Test Pattern should be seen to rotate 60°. At the completion of 360° prism rotation, the observer will have seen two (720°) complete rotations of the reticle and pattern. During the two rotations at least one arc of each set of three arcs, located in each quadrant of the Test Pattern and indicating a FOV of 1.7°, 1.8°, and 1.9°, must be visible on the reticle.
Sun Shafting Effect		
Command the introduction of sun reflection into the optical path, followed by the elimination thereof.	The rheostat labeled SUN SHAFTING INTENSITY on the SEXTANT protion of the Power Control Panel is turned clockwise against the limit stop, and then turned counterclockwise to the original position.	The observer should see the image of the Test Pattern gradually washed out on the reticle, followed by a return to full illumination and visibility.

Table 2-71. Sextant Functional Tests (Cont)

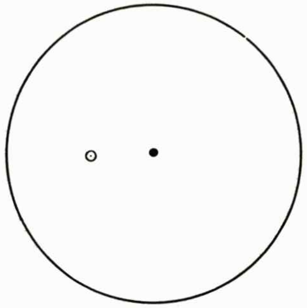
Commands	Procedures	Required Results
Manual Landmark Slide Retraction and Injection		
Command manual slide retraction from the Slide Gate.	The technician stationed near the Carousel presses the pushbutton labeled SLIDE RETURN on the Slide Actuation Electronics Assembly mounted on the Light Source Assembly housing.	The observer will see the Landmark Test Pattern Slide withdrawn from the Slide Gate into the Carousel Slide Magazine. During the retraction the Landmark Light Source will be extinguished, and the technician will report the lighting of SLIDE RETRACTED indicator light and the extinguishing of the SLIDE INJECTED light on the Electronics Assembly.
Command manual slide injection.	The technician at the Carousel presses the pushbutton labeled SLIDE INJECT on the Electronics Assembly.	The observer will see the Test Pattern slide in the Slide Gate and the Landmark optical path re-illuminated. The technician will report the relighting of the SLIDE INJECTED indicator and the extinguishing of SLIDE RETRACTED.
Carousel Rotation and Slide Actuation Interlocks		
Command removal of the circular cover on the top of the Carousel housing.	The technician at the Carousel loosens the four wing nuts (see Figure 1-8) and removes the Slide Magazine Removal Cover.	The Carousel Slide Magazine will be exposed, as well as the plunger actuated switch on the rim of the removal cover mounting flange. The MAG REMOVED light is lit.
Command actuation of the manual slide retraction.	The technician depresses the pushbutton on the Slide Actuation Electronics Assembly labeled SLIDE RETRACT.	No action will result from actuation of the switch, thus proving the electrical disabling of the Slide Actuation mechanism by removal of the Slide Magazine Cover.
Command manual depression of the plunger switch on the rim of the cover mounting flange, and at the same time actuation of the manual slide retraction, followed by release of the plunger switch.	The plunger switch is manually depressed and at the same time the SLIDE RETRACT switch of the Electronics Assembly is depressed, and then release of both switches.	The same result is observed as described for manual slide retraction, above.
Command selection of Landmark Slide No. 7 (or any slide in the Magazine other than the Test Pattern).	The Sextant Slide Selector rotary switch(es) is turned to the position commanded.	No action will result, thus proving the electrical disabling of the Carousel rotation by removal of the Magazine Slide Removal cover.

Table 2-71. Sextant Functional Tests (Cont)

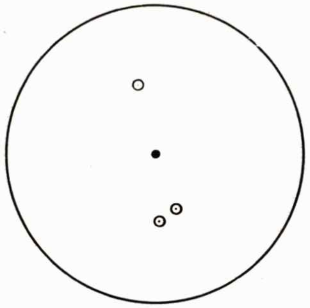
Commands	Procedures	Required Results
Command rotation of the Sextant Slide Selector switches to 0 - 0 and replacement of the Carousel Slide Magazine Removal Cover. NOTE Following conclusion of functional testing refer to paragraph 2-56 and return the Sextant to NORM, or operating condition. Negative results for any of the commanded tests will indicate the malfunctioning component by the wording of the Required Result.	The Sextant Slide Selector rotary switches are rotated to the 0 - 0 positions. The technician at the Carousel replaces the circular cover, tightening the wing nuts securely.	When the cover is securely fastened the Slide Actuation mechanism is re-enabled and the Test Pattern slide will be injected into the Slide Gate, with the Landmark optical path again illuminated. The MAG REMOVED light will go out and the SLIDE INJECTED light will be illuminated on the Slide Actuator Electronic Assembly.



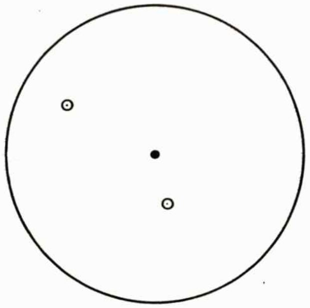
GROUP 1
α ANDROMEDAE



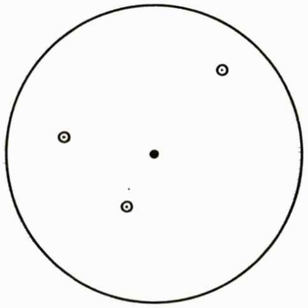
GROUP 2
β CETI



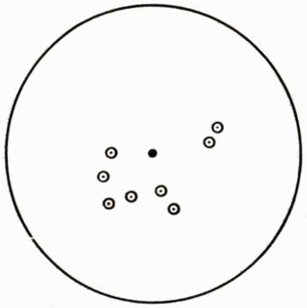
GROUP 3
α ERIDANI



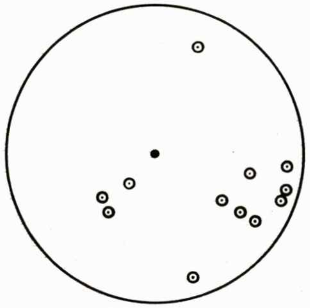
GROUP 5
α ARIETIS



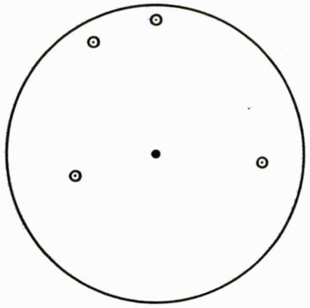
GROUP 6
α FORNAX



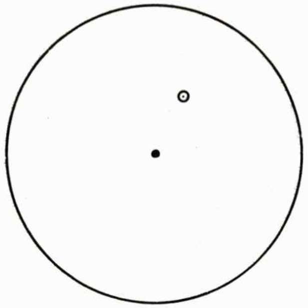
GROUP 7
α PERSEI



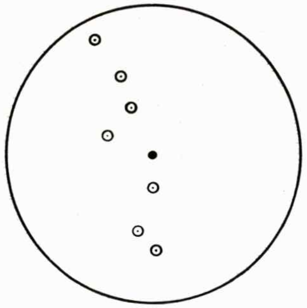
GROUP 8
α TAURI



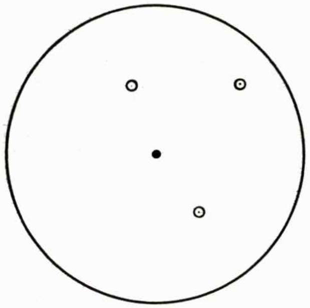
GROUP 9
α CANIS MAJORIS



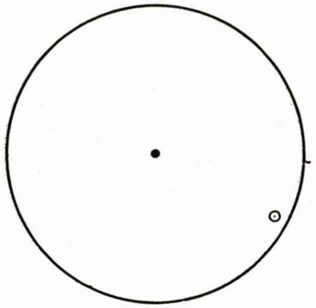
GROUP 10
β GEMINORUM



GROUP 11
τ VELORUM

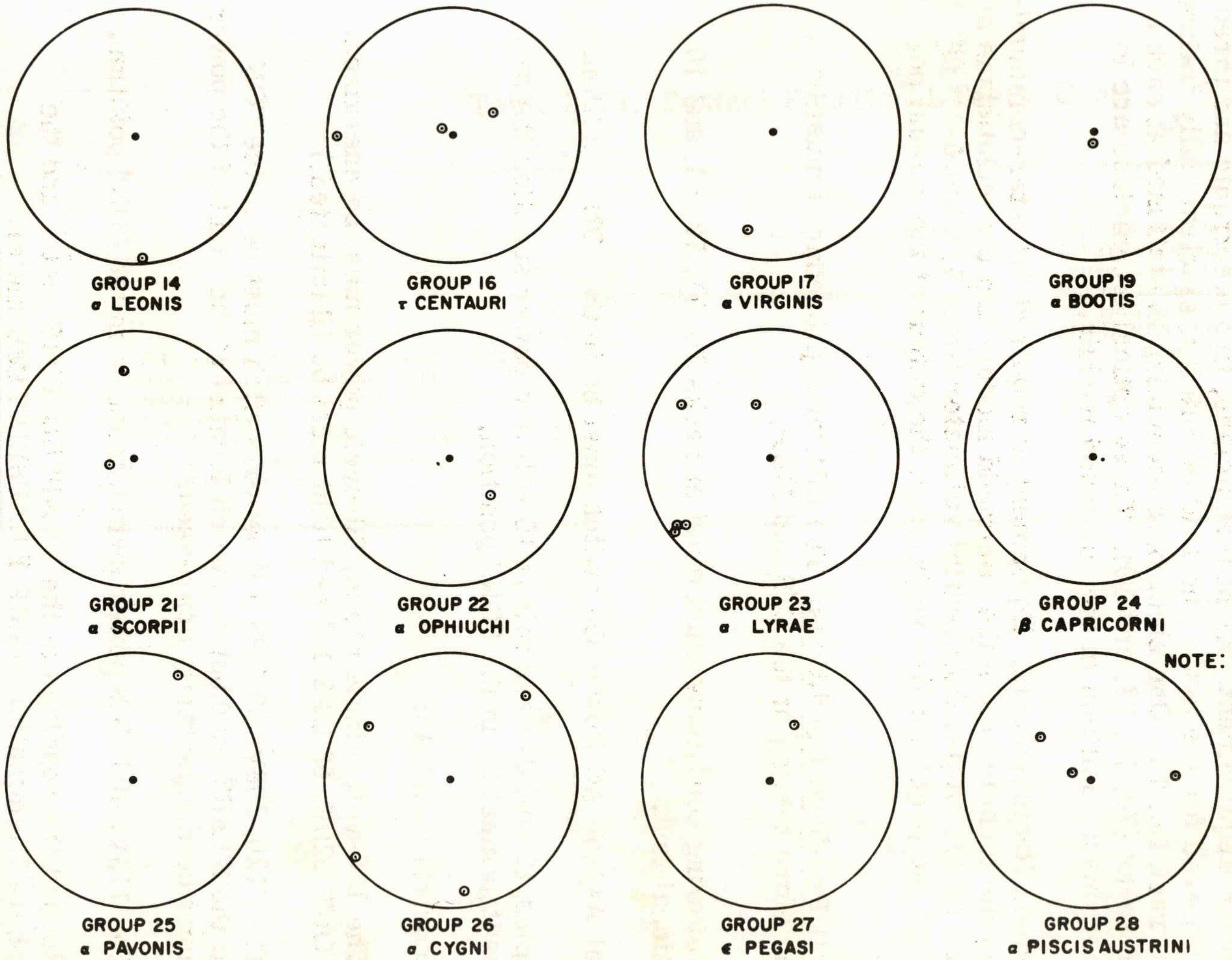


GROUP 12
β CARINAE



GROUP 13
α HYDRAE VSM2-66(1)

Figure 2-66. Sextant Star Groups (Sheet 1 of 2)



GROUP 14
α LEONIS

GROUP 16
τ CENTAURI

GROUP 17
α VIRGINIS

GROUP 19
α BOOTIS

GROUP 21
α SCORPII

GROUP 22
α OPHIUCHI

GROUP 23
α LYRAE

GROUP 24
β CAPRICORNI

GROUP 25
α PAVONIS

GROUP 26
α CYGNI

GROUP 27
ε PEGASI

GROUP 28
α PISCIS AUSTRINI

NOTE: THE FOLLOWING NAVIGATIONAL STARS HAVE NO "SURROUND" STARS, AND ARE NOT ILLUSTRATED:
- NO. 4 α URSAE MINORIS
- NO. 15 α URSAE MINORIS
- NO. 18 η URSAE MINORIS
- NO. 20 α CENTAURI

VSM2-66(2)

Figure 2-66. Sextant Star Groups (Sheet 2 of 2)

2-67. CELESTIAL SPHERE AND MISSION EFFECTS PROJECTOR.

2-68. The following manual tests serve to functionally test the celestial sphere and the MEP. This test is to be performed prior to each mission, or when a malfunction occurs in the C/S or MEP servo system.

2-69. Manpower and Equipment Requirement. Manpower and equipment requirements for the functional test are described in the following paragraphs.

2-70. Manpower Requirement. Eight technicians, five electronic and three optical, are required for the test. The lead technician, electronically trained, is stationed at rack No. 72. One electronic technician is stationed at each of the electronic racks (70, 71, 73, and 10). Three optical technicians are located at the astronaut positions in the command module.

2-71. Equipment Requirements. Equipment is required for inter-communication between the technicians in the command module and the technicians at the electronics racks. A d-c differential voltmeter (item 5, table 6-1), is required to read the precision d-c voltages at the output of the manual potentiometers.

2-72. General Pre-Test Conditions. The following procedures must be accomplished before testing of the C/S and MEP.

2-73. The following conditions must exist at racks 70, 71, 72, 73, and 10 prior to functional test.

a. At panel A4, the AC Power On switch must be in the "ON" position.

b. At the plus 10 volt d-c and minus 10 volt d-c power supplies the a-c POWER ON switch must be in the "ON" position.

c. At the control panel A3:

(1) The 120-volt, single phase, 60-cycle power must be energized. (The AUX. OUT 120V. 60 CPS 1 Ø red light must be illuminated.)

(2) The "120/208V. 60 CPS 3 Ø power switch must be in the "ON" position and the START pushbutton switch located at the right of the power on switch must be momentarily depressed.

(3) The 115V. 400 CPS power switch must be in the "ON" position.

(4) Record the readings of the ELAPSED TIME meter and the Celestial Sphere Illumination LAMP ELAPSED TIME meter.

d. At test panel I-A19:

(1) The ±10 VDC power switch must be in the "ON" position.

(2) The 26V. 400 CPS power switch must be in the "ON" position.

(3) Remove the four mounting screws and release the two quick-disconnect pushbuttons.

(4) Set all the AUTO-MAN selector switches to the "MAN" mode position.

e. At test panel II-A20

(1) Remove the four mounting screws and release the two quick-disconnect pushbuttons.

(2) Set all the AUTO-MAN selector switches to the "MAN" mode position.

f. At the arc lamp power supply cabinets, 88, 89, 90, 91, and 92, record the readings of the arc lamp elapsed time meters.

2-74. Before proceeding with the functional test check that indicator lamps are illuminated as follows:

a. Control panel A3

(1) The 120/208V. 60 CPS 3 Ø light above the START button.

(2) The 28V DC ON light.

(3) The ±10V DC light.

(4) The 115V 400 CPS light.

(5) The 115V 60 CPS 1 Ø light.

b. 28 Volt d-c power supply A4

(1) The three lights, AC POWER ON.

c. +10 Volt d-c power supply A21

(1) The POWER ON light.

d. -10 Volt d-c power supply A22

  (1) The POWER ON light.

e. Earth/Moon occultation, panel A5

  (1) X-AXIS light

  (2) Y-AXIS light

  (3) Z-AXIS light

f. LEM occultation panel A6 (Cabinets 72 and 73 only)

  (1) X-Axis light

  (2) Y-Axis light

  (3) Z-Axis light

g. Solar image panel A7 (Cabinets 70, 71, 72, and 73 only)

  (1) Pitch Axis light

  (2) Yaw Axis light

  (3) Focus light

h. Orbital view panel A8

  (1) Near Earth light

  (2) Mid-Moon light

i. Earth/Moon view selection trans-boundary illumination panel A9

  (1) Trans-Boundary Illumination lamp

NOTE

Indicator lights for turret drive I and turret drive II are illuminated only when the corresponding turret is indexing.

j. Attitude panel A11

  (1) Yaw Axis light

  (2) Pitch Axis light

(3) Roll Axis light

k. Off-course panel A12

(1) Off-Course I light

(2) Off-Course II light

(3) Extended Off-Course light

l. Special effects and terminator inclination, panel A13

(1) 28V DC Power ON light

(2) Terminator Rotator light

m. Vertical range panel A14

(1) Range I light

(2) Range II light

(3) Iris light

n. Earth/Moon illumination - terminator, panel A15

(1) Illumination I light

(2) Illumination II light

(3) Terminator light

o. Trans-boundary effects, panel A17

(1) Vertical Range light

(2) Limb Variation light

(3) Cassette Rotator light

p. Trans-Earth/Lunar view trans-boundary view, panel A18

(1) Trans-Earth light

(2) Trans-Lunar light

(3) Trans-Boundary light

q. Test panel I, panel A19

(1) Manual Mode indicator lights

(2) ±10VDC indicator light

(3) 26V 400 CPS indicator light

r. Test panel II, panel A20

(1) Manual Mode indicator lights

2-75. Celestial Sphere Pre-Test Conditions. The following conditions must exist prior to testing the C/S.

a. At the Celestial Sphere Panel A1:

(1) The 115V 400 CPS power switch must be in the "ON" position.

The amber indicating lamp adjacent to the switch must be lit.

(2) The 28 VDC power switch must be in the "ON" position. The red indicator lamp adjacent to the switch must be lit.

b. At the celestial sphere roll axis power amplifier, panel A2:

(1) The a-c power switch must be in the "ON" position. The red light above the switch must be lit.

(2) The OUTPUT switch must be in the "ON" position. The red light above this switch must be lit.

2-76. Illumination Turn-On Procedure. Illumination for the C/S is energized from panel A3 as follows:

a. Turn the Celestial Sphere Illumination "120/208 V 60 CPS 3 Ø" power switch to the "ON" position.

b. Set the LAMP VOLTAGE CONTROL to the "NORMAL" position.

c. Depress the LAMP START pushbutton switch.

d. Allow 20 minutes for warm up and stabilization.

e. Adjust the LAMP VOLTAGE CONTROL until the LAMP CURRENT meter reads 7.8 amps nominally.

f. The celestial presentation should now be present at all windows and the telescope.

2-77. Testing Procedure. Table 2-72 outlines the commands and procedures to be followed when testing the C/S plus the results required to prove that the servo systems are performing normally.

Table 2-72. Celestial Sphere and Occulting Illuminator Functional Tests

Command	Procedure	Required Results
Celestial Sphere and Occulting Illuminator		
a. Command simulated zeroing of the Command Module with reference to the celestial starfield.	a. Required operations are performed on Test Panel 1-A19. Set the C/S Roll manual resolver at 0 degrees Set the C/S Yaw manual resolver at 0 degrees Set the C/S Pitch manual resolver at 0 degrees	a. The celestial starfield will rotate and come to rest with the 3 axes on the Celestial Sphere Assembly aligned to their respective indices.
b. Command simulated slow rotation through 360° in both directions of the Command Module about the Roll Axis.	b. The C/S Roll manual resolver is slowly and smoothly rotated through one complete revolution in both directions.	b. The celestial starfield will change 360° in one direction and 360 degrees in the other direction about the Roll Axis.
c. Command simulated slow rotation through 360° in both directions of the Command Module about the Yaw Axis.	c. The C/S Yaw manual resolver is slowly and smoothly rotated through one complete revolution in both directions.	c. The celestial starfield will change 360° in one direction and 360° in the other direction about the Yaw Axis.
d. Command simulated slow rotation through 360° in both directions of the Command Module about the Pitch Axis.	d. The C/S pitch manual resolver is slowly and smoothly rotated through one complete revolution in both directions.	d. The celestial starfield will change 360° in one direction and 360° in the other direction about the Pitch Axis.
Earth/Moon Occultation		
e. Command simulated Earth's occlusion of the celestial starfield from the center of the field to maximum left and right and back to the center of the field.	e. The manual control potentiometer on Test Panel 1-A19 labeled Earth/Moon Occultation Y Axis is varied from 0V. D.C. to -9.49V. D.C. to +9.494V. D.C. and back to 0V. D.C. at test points TP28 to D.C. Signal Ground.	e. The Earth's occlusion of the celestial starfield will move from the center of the field to maximum left and right and back to the center of the field.
f. Command simulated Earth's occlusion of the celestial starfield from minimum to maximum and back to minimum.	f. The manual control potentiometer on Test Panel 1-A19 labeled Earth/Moon Occultation Z Axis is varied from -10V. D.C. to +8.984V. D.C. and back to -10V. D.C. at test points TP30 to D.C. Signal Ground.	f. The Earth's occlusion of the celestial starfield will move from minimum occlusion to maximum occlusion and back to minimum occlusion.
g. Command simulated Earth's occlusion of the celestial starfield from the center of the field to maximum up and down and back to the center of the field.	g. The manual control potentiometer on Test Panel 1-A19 labeled Earth/Moon Occultation X Axis is varied from 0V. D.C. to -9.494V. D.C. to +9.494V. D.C. and back to 0V. D.C. at test points TP26 to D.C. Signal Ground.	g. The Earth's occlusion of the celestial starfield will move from the center of the field to maximum up and down and back to the center of the field.

Table 2-72. Celestial Sphere and Occulting Illuminator Functional Tests (Cont)

Command	Procedure	Required Results
L.E.M. Occultation (Racks 72 and 73)		
h. Command the simulated Lunar Excursion Module's (L.E.M.) occlusion of the celestial starfield from the center of the field to maximum left and right and back to the center of the field.	h. The manual control potentiometer of Test Panel 1-A19 labeled L.E.M. Occultation Y Axis is varied from 0V. D.C. to -9.49V. D.C. to +9.494V. D.C. and back to 0V. D.C. at test points TP34 to D.C. Signal Ground.	h. The L.E.M. occlusion of the celestial starfield will move from the center of the field to maximum left and right and back to the center of the field.
i. Command the simulated Lunar Excursion Module's (L.E.M.) occlusion of the celestial starfield from minimum to maximum and back to minimum.	i. The manual control potentiometer of Test Panel 1-A19 labeled L.E.M. Occultation Z Axis is varied from -10V. D.C. to +8.244V. D.C. and back to -10V. D.C. at test points TP36 to D.C. Signal Ground.	i. The L.E.M. occlusion of the celestial starfield will move from minimum occlusion to maximum occlusion and back to minimum occlusion.
j. Command the simulated Lunar Excursion Module's (L.E.M.) occlusion of the celestial starfield from the center of the field to maximum up and down and back to the center of the field.	j. The manual control potentiometer on Test Panel 1-A19 labeled L.E.M. Occultation X Axis is varied from 0V. D.C. to -9.494V. D.C. to +9.494V. D.C. and back to 0V. D.C. at test points TP32 to D.C. Signal Ground.	j. The L.E.M. occlusion of the celestial starfield will move from the center of the field to maximum up and down and back to the center of the field.

2-78. Mission Effects Projector Pre-Test Conditions. Functional testing of the servo and control systems of the mission effects projector (M.E.P.) serves to check out the electrical, mechanical and optical functioning of this image generating unit.

2-79. The following pre-test conditions must exist at the MEP assembly and electronic racks 70, 71, 72, 73 and 10 prior to test.

a. Turret I position A must be loaded with earth orbital film.

b. Turret II position A must be loaded with color frames showing varying diameters of the earth.

c. Turret I position C must be loaded with color frames showing varying diameters of the moon.

d. Turret II position C must be loaded with moon orbital film.

e. Trans-Boundary films must be loaded in the transboundary cassette.

2-80. Test of the MEP Turret No. I and Turret No. II Projection Systems. Perform the following steps at Test Panel I-A19 prior to test.

a. Set the CASSETTE SELECTION, TURRET I selector switch to position "A" and depress the TURRET I INDEX pushbutton switch. Wait three (3) minutes.

b. Set the QUICK DISSOLVE selector switch to the "TURRET I" position. Depress the START pushbutton switch.

2-81. Perform the following steps at the Air Compressor for cooling the MEP film, prior to test.

a. Turn on the air compressor per procedure in Section II (Turn-On Procedures.)

b. The AIR PRESSURE ON indicator lamp on control panel A3 should be illuminated.

2-82. Perform the following steps at the arc lamp power supplies cabinets 88, 89, 90, 91, and 92.

a. Set the REMOTE-OFF-MANUAL toggle switches to the "REMOTE" position for all mission film, trans-boundary and solar arc lamp power supplies.

b. Set the LAMP CURRENT ADJUST potentiometers on all power supplies to the "START" position.

2-83. Perform the following steps at the trsns-boundary lamp controls on test panel II-A20 and test panel 1-A19.

a. Turn the TRANS-BOUNDARY LAMP selector switch to the "LAMP OFF" position.

b. Turn the SOLAR LAMP selector switch to the "LAMP OFF" position.

2-84. Perform the following steps at the mission film lamp controls on test panel II-A20.

a. Turn the MISSION FILM LAMP selector switch to the "PRIME" position.

b. Wait 30 seconds and depress the MISSION FILM LAMP MAN IGNITE pushbutton to ignite the arc lamp.

c. Allow 20 minutes for warm-up and stabilization.

2-85. The following indicator lights should be illuminated.

a. Control panel A3

(1) "Mission Film Arc Lamp On" red light.

b. Arc lamp power supplies cabinets 88, 89, 90, 91 and 92

(1) "Mission Film" "DC On" green light.

(2) "Mission Film" "Lamp On" red light.

2-86. The following pre-test conditions must exist at test panel I-A19 prior to test.

a. The ATTITUDE/PITCH manual control resolver must be set at "0°", with the image at the center of the field of view. (Rotate the resolver dial clockwise from the initial turn-on position.)-

b. The Attitude/Yaw manual control resolver must be set at "0°" with the image at the center of the field of view.

c. The Attitude/Roll manual control resolver must be set at "0°".

2-87. Perform the following step at the mission film lamp controls on test panel II-A20.

a. Turn the MISSION FILM LAMP selector switch to the "HALF POWER" position. The illumination of the film should now be decreased.

b. The ARC LAMP POWER SUPPLY/HALF POWER red indicator light on test panel II-A20 should be illuminated.

c. Turn the MISSION FILM LAMP selector switch back to "PRIME".

d. Allow five minutes for restabilization of the arc lamp.

CAUTION

PROTECTIVE EYEGLASSES MUST BE WORN AT ALL TIMES WHEN DIRECTLY VIEWING THE ARC LAMP.

2-88. Perform the following steps at test panel I-A19.

a. Set the EXTENDED OFF-COURSE selector switch to the "MAN SCALE 1" position. Set the manual control potentiometer to "zero vdc at test points TP84 to d-c signal ground. Set the MAN IX-INCR RT toggle switch to the "IX" position.

b. Set the OFF-COURSE I selector switch to the "MAN SCALE 1" position. Set the manual control potentiometer to "+1.849vdc, at test points TP76 to d-c signal ground.

2-89. Perform the following steps at test panel II-A20.

a. Set the three MANUAL FLIGHT DIRECTION, EARTH, MOON and TRANS-BOUNDARY toggle switches to the "REVERSE" position.

b. Set the EARTH BLANKING selector switch to the "MAN OPEN" position.

c. Set the Horizon Mask selector switch to the "MAN CLOSED" position.

d. Set the TURRET I DISTORTION LENS selector switch to the "MAN OUT" position.

e. Set the TERMINATOR manual control potentiometer to "0v dc" at test points TP59 to d-c signal ground. Depress the momentary contact TERMINATOR/MAN IX-INCR RT toggle switch to the "IX" position.

f. Set the TERMINATOR ROTATOR manual control potentiometer to "0v dc" at test points TP61 to d-c signal ground.

g. Set the Earth/Moon Illumination I manual control potentiometer to "+10v dc" at test points TP55 to d-c signal ground, depress the momentary contact Illumination I/MAN IX-INCR RT toggle switch to the "IX" position.

h. Set the VERTICAL RANGE I manual control potentiometer to "-10 v dc" at test points TP49 to d-c signal ground. Depress the momentary contact VERTICAL RANGE I/MAN IX-INCR RT toggle switch to the "IX" position.

i. Set the IRIS manual control potentiometer to "-10v dc" at test points TP53 to d-c signal ground.

j. Depress the EARTH ORBITAL VIEW/MAN IX pushbutton switch and rotate the resolver dial for the EARTH ORBITAL VIEW such that a usable portion of the earth film is in the center of the field.

2-90. Testing Procedure. Table 2-73 outlines the commands and procedures to be followed when testing the MEP plus the results required to prove that the servo systems are performing normally.

Table 2-73. Mission Effects Projector (MEP) Functional Tests

Command	Procedure	Required Results
Turret I Leg		
a. Command simulated orbiting of the Command Module around the earth.	a. The manual resolver on Test Panel 1-A20, "Earth Orbital View" is rotated slowly and smoothly through 360°.	a. The Earth's terrain will move across each window and telescope field of view.
b. Command a simulated increase in altitude and a decrease in altitude of the Command Module.	b. The manual control potentiometer on Test Panel 11-A20 "Vertical Range 1" is varied from -10 volts dc to +10 volts dc and back to -10 volts at test points TP49 to dc signal ground with the momentary contact "MAN IX-INCR RT" switch depressed to the "INCR RT" position. Repeat the above with the "MAN IX-INCR RT" switch depressed to the "IX" position. NOTE At +10 volts dc and -10 volts dc the increased rate will automatically be reset to the normal rate.	b. The size of the Earth's terrain features will decrease and then increase proportional to the change in altitude above the earth, first at an increased rate and then at normal speed.
c. Command simulated off-course motion of the Command Module from the desired orbit to maximum drift off-course in one direction to maximum drift off-course in the other direction and back to the desired orbit.	c. The manual control potentiometer on Test Panel 1-A19 "Off-Course I" is varied from +1.849 volts dc to +10 volts dc to -6.302 volts dc and back to +1.849 volts dc at test points TP76 to D.C. signal ground.	c. The Earth's terrain will move across each window and telescope from the desired orbit to maximum drift off-course in one direction, to maximum drift off-course in the other direction and back to the desired orbit.
d. Command simulated maximum to minimum and back to maximum illuminated spot size of the Earth's terrain.	d. The manual control potentiometer on Test Panel 11-A20 "Vertical Range I" is set at +10 volts dc at test points TP49 to d-c signal ground. The manual control potentiometer on Test Panel 11-A20 "Illumination I" is varied from +10 volts dc to -10 volts dc and back to +10 volts dc at test points TP55 to dc signal ground. The "Man IX-INCR RT" momentary contact switch is depressed to the "INCR RT" position. Repeat the above with the "Man IX-INCR RT" momentary contact switch depressed to the "IX" position. Reset the manual control potentiometer on Test Panel 11-A20 "Vertical Range I" to -10 volts dc at test points TP49 to d-c signal ground. NOTE At +10 volts dc and -10 volts dc the increased rate will automatically be reset to the normal rate.	d. The illuminates spot size of the Earth's terrain will decrease and then increase back to the maximum spot size. First, this occurs at an increased rate and then at the normal rate.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Command	Procedure	Required Results
Turret I Leg (Cont)		
e. Command slow darkening of the Earth view to complete blackout and back again.	e. On Test Panel 11-A20 the manual control potentiometer "IRIS" is varied from -10 volts dc to +10 volts dc and back to -10 volts dc at test points TP53 to d-c signal ground.	e. The Earth view will change slowly from full brightness to complete blackout and then return slowly to complete brightness.
f. Command distortion of the Earth View to achieve curvature of the Earth's surface.	f. On Test Panel 11-A20 set the "Turret II Distortion Lens" selector switch to the "Manual In" and then the "Manual Out" position.	f. The Earth's surface will appear to be curved and then will be back to normal.
g. Command movement of the terminator across the Earth View in both directions.	g. The manual control potentiometer on Test Panel 11-A20 "Terminator" is varied from 0 volts dc to -10 volts dc to +7.445 volts dc and then back to 0 volts dc at test points TP59 to d-c signal ground. The above is done with the momentary contact "Man IX-INCR RT" switch depressed to the "IX" position. Set the manual control potentiometer at -10 volts dc then quickly change the setting to +7.445 volts dc. Depress the momentary contact "Man IX-INCR RT" switch to the "INCR RT" position. Set the manual control potentiometer to 0 volts dc and depress the "Man IX-INCR RT" momentary contact switch to the "IX" position.	g. The Earth view will vary from complete view through partial occlusion to complete darkening through partial occlusion to complete view through partial occlusion to complete darkening through partial occlusion and back to a complete view. The terminator will rapidly move across the field of view. First night will be present then day then night and back to day.
h. Command inclination of the "Terminator" from 0° to +90° to -90° and back to 0°.	h. On Test Panel 11-A20, set the "Terminator" manual control potentiometer to +5.0 volts dc at test points TP59 to d-c signal ground. Vary the "Terminator Rotator" manual control potentiometer from 0 volts dc to +10 volts dc to -10 volts dc and back to 0 volts dc at test points TP61 to d-c signal ground Reset the "Terminator" to 0 volts dc at test points TP59 to dc- signal ground.	h. The Terminator will be rotated from the horizontal position at 0 degrees to the vertical position at +90 degrees and at -90 degrees and then back to the horizontal position at 0 degrees.
i. Command attitude zeroing of the Control Module.	i. On Test Panel 1-A19, rotate the "Attitude", "pitch" and "yaw" manual resolvers slowly and smoothly until the earth view is in the center of the field with the resolver dials set at 0 degrees. Rotate the "roll" manual resolver slowly and smoothly until the dial indicates 0 degrees and the "earth orbital view" manual resolver on test panel 11-A20 controls the earth view in such a way as to move the earth view up with decreasing angle on the resolver dial.	i. The attitude of the Command Module will be in its zeroed position.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Command	Procedure	Required Results
Turret I Leg (Cont)		
j. Vary the attitude of the Command Module around the Yaw Axis from the zeroed position to the left and right and back to the zeroed position	j. The manual resolver "Attitude Yaw" is rotated slowly and smoothly 360 degrees through decreasing angles on the dial, then increasing angles on the dial, and then back to 0 degrees with the Earth view in the center of the field.	j. The Command Module will yaw to the left and right and then back to the center of the field.
k. Vary the attitude of the Command Module around the "Pitch" axis from the zeroed position up and down and back to the zeroed position.	k. The manual resolver "Attitude Pitch" is rotated slowly and smoothly 360 degrees through decreasing angles on the dial, then increasing angles on the dial and then back to 0 degrees with the Earth view in the center of the field.	k. The Command Module will pitch up and down and then back to the center of the field.
l. Vary the attitude of the Command Module around the "Roll" axis from the zeroed position clockwise and counterclockwise and back to the zeroed position.	l. The manual resolver "Attitude Roll" is rotated slowly and smoothly 360 degrees through increasing angles on the dial, then decreasing angles on the dial, and then back to 0 degrees and the zeroed position indicated above.	l. The Command Module will roll clockwise and counterclockwise and back to the zeroed position.

NOTE: The attitude of the earth view will move in a direction opposite to the attitude of the control module.

Command	Procedure	Required Results
m. Command rewinding of the "Earth View" film.	m. Depress the momentary contact "Earth Orbital View" "Man INCR RT - Rewind" switch on Test Panel 11-A20 to the "Rewind" position.	m. The "Earth View" film will rewind automatically to the starting point.

n. Set the manual control potentiometer EARTH/MOON ILLUMINATION II on Test Panel II-A20 to +10 volts dc at test points TP57 to d-c signal ground.

o. Set the manual control potentiometer VERTICAL RANGE II on Test Panel II-A20 to -10 volts dc at test points TP51 to dc signal ground.

p. On Test Panel I-A19 set the OFF-COURSE II selector switch to the "MANUAL SCALE - 1" position. Set the manual control potentiometer OFF-COURSE II to +1.849 volts dc at test points TP80 to d-c signal ground.

q. Set the TURRET II CASSETTE SELECTOR switch on Test Panel I-A19 to position "C" and depress the TURRET II INDEX pushbutton switch.

r. Wait 3 minutes.

s. Set the QUICK DISSOLVE selector switch on Test Panel I-A19 to the "TURRET II" position and depress the QUICK DISSOLVE START pushbutton switch.

NOTE: The Moon Orbital View film should now be in the field of view.

t. Set the TURRET I CASSETTE SELECTOR switch on Test Panel I-A19 to position "C" and depress the TURRET I INDEX pushbutton switch.

u. Wait 3 minutes

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Turret I Leg (Cont)

v. Set the QUICK DISSOLVE selector switch on Test Panel I-A19 to the "TURRET I" position and depress the QUICK DISSOLVE START pushbutton switch.

NOTE: The Trans-Lunar View slides should now be in the field of view

w. Rotate the TRANS-LUNAR manual resolver on Test Panel II-A20 such that a usable portion of the Trans-Lunar film is in the field of view.

Command	Procedure	Required Results
x Command simulated lunar view trajectory flight.	x. The "Trans-Lunar View" manual resolver on Test Panel 11-A20 is rotated slowly and smoothly through 360 degrees on the dial.	x. Slides of varying diameters of the Moon will move across each window and telescope.
y. Command rewinding of the "Trans-Lunar View" film.	y. On Test Panel 11-A20 depress the "Trans-Lunar View Manual Film Rewind" pushbutton switch.	y. The "Trans-Lunar View" film will rewind automatically to the starting point.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Command	Procedure	Required Results
Turret II Leg		
a. Command test of turret II leg.	a. Set the "Quick Dissolve" selector switch on Test Panel 1-A19 to the "Turret II" position and depress the "Quick Dissolve Start" pushbutton switch. Set the "Turret II Distortion Lens" selector switch on Test Panel 11-A20 to the "Manual Out" position. On Test Panel 11-A20 depress the "Moon Orbital View Man. IX" pushbutton switch and rotate the resolver dial for the "Moon Orbital View" such that a usable portion of the Moon film is in the center of the field.	
b. Command simulated orbiting of the Command Module around the Moon.	b. The manual resolver on Test Panel 11-A20 "Moon Orbital View" is rotated slowly and smoothly through 360 degrees	b. The Moon's terrain should move across each window and telescope field of view.
c. Command a simulated increase in altitude and a decrease in altitude of the Command Module.	c. The manual control potentiometer on Test Panel 11-A20 "Vertical Range II" is varied from -10 volts dc to +10 volts dc and back to -10 volts dc at test points TP51 to d-c signal ground, with the momentary contact "Man IX-INCR RT" switch depressed to the "INCR RT" position. Repeat the above with the "Man IX-INCR RT" switch depressed to the "IX" position.	c. The size of the Moon's terrain features should decrease and then increase proportional to the change in attitude above the Moon first at an increased rate and then at normal speed.
d. Command simulated off-course motion of the Command Module from the desired orbit to maximum drift off-course in one direction to maximum drift off-course in the other direction and back to the desired orbit	d. The manual control potentiometer on Test Panel 1-A19 "Off-Course II" is varied from +1.849 volts dc to +10 volts dc to -6.302 volts dc and back to +1.849 volts dc at test points TP80 to d-c signal ground.	d. The Moon's terrain should move across each window and telescope from the desired orbit to maximum drift off-course in one direction to maximum drift off-course in the other direction and back to the desired orbit.
e. Command simulated maximum to minimum and back to maximum illuminated spot size of the Moon's terrain.	e. The manual control potentiometer on the Test Panel 11-A20 "Vertical Range II" is set at +10 volts dc at test points TP51 to d-c signal ground. The manual control potentiometer on Test Panel 11-A20 "Illumination II" is varied from +10 volts dc to -10 volts dc and back to +10 volts dc at test points TP55 to d-c signal ground. The "Man IX-INCR RT" momentary contact switch is depressed to the "Man IX-INCR RT" position. Repeat the above with the "Man IX-INCR RT" momentary contact switch depressed to the "IX" position. Reset the manual control potentiometer on Test Panel 1-A20 "Vertical Range II" to -10 volts dc at test points TP51 to d-c signal ground.	e. The illuminated spot size of the Moon's terrain should decrease and then increase back to the maximum spot size. First this occurs at an increased rate and then at the normal rate.

NOTE: At +10 volts dc and -10 volts dc the increased rate will automatically be reset to the normal rate.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Command	Procedure	Required Results
Turret II Leg (Cont)		
f. Command distortion of the Moon view to achieve curvature of the Moon's surface	f. On Test Panel 11-A20 set the "Turret II Distortion Lens" selector switch to the "Manual In" and then "Manual Out" position.	f. The Moon's surface will appear to be curved and then will be back to normal.
g. Command rewinding of the "Moon View" film.	g. Depress the momentary contact "Moon Orbital View" "Man INCR RT - Rewind" switch on Test Panel 11-A20 to the "Rewind" position.	g. The "Moon View" film will rewind automatically to the starting point.
h. Set the "Turret I Cassette Selector" switch on Test Panel 1-A19 to position "A" and depress the "Turret I Index" pushbutton switch.		
i. Wait 3 minutes.		
j. Set the "Quick Dissolve" selector switch on Test Panel 1-A19 to the "Turret I" position and depress the "Quick Dissolve Start" pushbutton switch.		
NOTE: The "Earth Orbital View" film should now be in the field of view.		
k. Set the "Turret II Cassette Selector" switch on Test Panel 1-A19 to position "A" and depress the "Turret II Index" pushbutton switch.		
l. Wait 3 minutes.		
m. Set the "Quick Dissolve" selector switch on Test Panel 1-A19 to the "Turret II" position and depress the "Quick Dissolve Start" pushbutton switch.		
NOTE: The "Trans-Earth View" slides should now be in the field of view.		
n. Rotate the "Trans-Earth" manual resolver on Test Panel 11-A20 such that a usable portion of the "Trans-Earth" film is in the field of view.		
o. Command simulated Earth view trajectory flight.	o. The "Trans-Earth View" manual resolver on Test Panel 11-A20 is rotated slowly and smoothly through 360 degrees on the dial.	o. Slides of varying diameters of the Earth will move across each window and telescope.
p. Command rewinding of the "Trans-Earth View" film.	p. On Test Panel 11-A20 depress the "Trans-Earth View Manual Film Rewind" pushbutton switch.	p. The "Trans-Earth" film will rewind automatically to the starting point.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Trans-Boundary Leg

a. Preset Conditions

(1) Set the QUICK DISSOLVE selector switch on Test Panel I-A19 to the "TURRET I" position and depress the QUICK DISSOLVE/START pushbutton.

NOTE: The "Earth Orbital View" film should now be in the field of view.

(2) Set the TRANS-BOUNDARY BLANKING selector switch on Test Panel II-A20 to the "MANUAL OPEN" position.

(3) On Test Panel II-A20 perform the following steps.

(a) Turn the "Trans-Boundary Lamp" selector switch to "Prime".

(b) Wait 30 seconds and depress the "Trans-Boundary Manual Ignite" pushbutton switch to ignite the arc lamp.

(c) Allow 20 minutes for warm-up and stabilization.

(d) The following indicator lights now should also be illuminated.

(1) Control Panel A3

TRANS-BOUNDARY ARC LAMP ON red light.

(2) Arc Lamp Power Supplies Cabinets 88, 89, 90, 91 and 92.

TRANS-BOUNDARY D.C. ON green light.

TRANS-BOUNDARY LAMP ON red light.

(e) Turn the TRANS-BOUNDARY LAMP selector switch to "HALF POWER" and the illumination of the film should be decreased.

(f) The HALF POWER indicator light on Test Panel II-A20 should be illuminated.

(g) Turn the TRANS-BOUNDARY LAMP selector switch back to "PRIME".

(h) Allow 5 minutes for restabilization of the arc lamp.

(4) Set the Trans-Boundary Illumination manual control potentiometer on Test Panel II-A20 to -10 volts dc at test points TP41 to d-c signal ground. Depress the momentary contact MANUAL IX-INCR RT switch to the "INCR RT" position.

(5) Set the TRANS-BOUNDARY LIMB VARIATION manual control potentiometer on Test Panel II-A20 to -10 volts dc at test points TP45 to d-c signal ground. Depress the momentary contact Manual IX-INCR RT switch to the "INCR RT" position.

(6) Set the TRANS-BOUNDARY VERTICAL RANGE manual control potentiometer on Test Panel II-A20 to +2 volts dc at test points TP43 to d-c signal ground. Depress the momentary contact MANUAL IX-INCR RT switch to the "INCR RT" position.

(7) Set the TRANS-BOUNDARY CASSETTE ROTATOR manual control potentiometer on Test Panel II-A20 to 0 volts dc at test points TP47 to d-c signal ground.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Trans-Boundary Leg (Cont)

(8) On Test Panel II-A20 depress the TRANS-BOUNDARY VIEW MANUAL IX pushbutton switch and rotate the resolver dial for the TRANS-BOUNDARY VIEW such that the cloud cover portion of the Trans-Boundary film is in the center of the field.

(9) On Test Panel I-A19 rotate the attitude pitch manual resolver 360 degrees clockwise.

Command	Procedure	Required Results
b. Test		
(1) Command motion of the "Trans-Boundary View" film.	a. The manual resolver on Test Panel II-A20 "Trans-Boundary View" is rotated slowly and smoothly through 360 degrees.	a. The cloud cover presentation around the Earth's horizon should move across each window and telescope field of view.
(2) Command a simulated decrease and increase in diameter of the cloud cover around the Earth's horizon.	b. On Test Panel II-A20 vary the manual control potentiometer "Trans-Boundary Limb Variation" from -10 volts dc to +10 volts dc and back to -10 volts dc at test points TP45 to d-c signal ground.	b. The cloud cover around the Earth's horizon should decrease and then increase in diameter.
(3) Command a simulated decrease and increase in altitude of the Command Module with respect to the cloud cover around the Earth's horizon.	c. On Test Panel II-A20 vary the manual control potentiometer "Trans-Boundary Vertical Range" from +2 volts dc to -10 volts dcand back to +2 volts dc at test points TP43 to d-c signal ground.	c. The cloud cover around the Earth's horizon should increase and then decrease in diameter.
(4) Command a simulated minimum to maximum and back to minimum illuminated spot size of the cloud cover around the Earths horizon.	d. On Test Panel II-A20 vary the manual control potentiometer "Trans-Boundary Illumination" from -10 volts dc to +10 volts dc and back to -10 volts dc at test points TP41 to d-c signal ground.	d. The cloud cover around the Earth's horizon should increase and then decrease in diameter.
(5) Command a simulated extended off-course motion of the Control Module with respect to the cloud cover around the Earth's horizon.	e. On Test Panel II-A20 vary the manual control potentiometer "Trans-Boundary Cassette Rotator".	e. The angle of the Command Module should vary off-course from 0 degrees to 50 degrees clockwise to 50 degrees counterclockwise and back to 0 degrees with respect to the cloud cover around the Earth's horizon.
(6) Command a simulated extended off-course motion of the Control Module from the desired orbit to maximum in one direction, to maximum in the other direction and back to the desired orbit.	f. On Test Panel I-A19 vary the manual control potentiometer "Extended Off-Course" from 0 volts dc to +10 volts dc to -10 volts dc and back to 0 volts dc at test points TP84 to d-c signal ground. The "Manual IX-INCR RT" toggle switch should be in the "INCR RT" position.	f. The cloud cover around the earth's horizon should cover the Earth view presentation first from the right then from the left and then back the the full Earth View presentation.
(7) Command Blanking and reappearance of the "Trans-Boundary" presentation.	g. On Test Panel II-A20 turn the "Trans-Boundary Blanking" selector switch to the "Manual Closed" and back to the "Manual Open" position.	g. The cloud cover around the Earth's horizon should be blanked out and then should reappear.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Trans-Boundary Leg (Cont)

Command	Procedure	Required Results
(8) Command blanking and reappearance of the Earth view and "Trans-Boundary" view presentations.	h. On Test Panel II-A20 turn the "Earth Blanking" selector switch to the "Man. Closed" and then the "Manual Open" positions.	h. The Earth and "Trans-Boundary" view will be blanked out and then will reappear.
(9) Command simulated sunrise and sunset.	i. On Test Panel II-A20 set the manual control potentiometer "Trans-Boundary Illumination" to +10 volts dc at test points TP41 to d-c signal ground. On test panel II-A20, turn the "Horizon Mask" selector switch to the "Manual Open" and then the "Manual Closed" position. Reset the manual control potentiometer "Trans-Boundary Illumination" to -10 volts dc at test points TP41 to d-c signal ground.	i. A red-orange scallop should appear and then disappear slowly around the outer diameter of the cloud cover.
(10) Command rewinding of the "Trans-Boundary View" film.	j. On Test Panel II-A20 depress the momentary contact "Trans-Boundary INCR RT-Rewind" switch to the "Rewind" position.	j. The "Trans-Boundary View" film will rewind automatically to the starting position.
(11) On Test Panel I-A19 rotate the "Attitude Pitch" manual resolver 360 degrees counterclockwise.		

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Solar Image Projector

NOTE

The following instructions and tests are not to be performed on Cabinet 10 and the Telescope MEP.

a. Preset Conditions

(1) On Test Panel II-A20 set the "Earth Blanking" selector switch to the "Manual Closed" position.

(2) On Test Panel I-A19 perform the following steps.

(a) Turn the SOLAR LAMP selector switch to "PRIME".

(b) Wait 30 seconds and depress the SOLAR MANUAL IGNITE pushbutton switch to ignite the arc lamp.

(c) Allow 20 minutes for warm-up and stabilization.

(d) The following indicator lights now should also be illuminated.

(1) Control Panel A3.

SOLAR LAMP ON red light.

(2) Arc Lamp Power Supplies Cabinets 89, 90, 91 and 92.

SOLAR D.C. ON green light.

SOLAR LAMP ON red light.

(e) Turn the SOLAR LAMP selector switch to "HALF POWER" position and the illulination of the solar image should be decreased.

(f) The HALF POWER red indicator light on Test Panel II-A20 should be illuminated.

(g) Turn the SOLAR LAMP selector switch back to "PRIME".

(h) Allow 5 minutes for restabilization of the arc lamp.

(3) On Test Panel I-A19 set the SOLAR IRIS selector switch to the "MANUAL OUT" position.

(4) On Test Panel I-A19 set the SOLAR BLANKING selector switch to the "MANUAL OPEN" position.

(5) On Test Panel I-A19 set the manual control potentiometer SOLAR PITCH to 0 volts dc at test points TP86 to d-c signal ground.

(6) On Test Panel I-A19 set the manual control potentiometer SOLAR YAW to 0 volts dc at test points TP88 to d-c signal ground.

(7) On Test Panel I-A19 set the manual control potentiometer Solar Focus such that the solar image presentation is in sharp focus.

Table 2-73. Mission Effects Projector (MEP) Functional Tests (Cont)

Command	Procedure	Required Results
Solar Image Projector (Cont)		
b. Test		
(1) Command motion of the solar image presentation around the "Solar Pitch" axis from the center of the field to maximum left and right and back to the center of the field.	a. On Test Panel I-A19 vary the manual control potentiometer "Solar Pitch" from 0 volts dc to +10 volts dc to -10 volts dc and back to 0 volts dc. Vary the "Solar Focus" manual control potentiometer to maintain the solar image in focus.	a. The solar image will move from the center of the field to masimum left and right and back to the cneter of the field.
(2) Command motion of the solar image presentation around the "Solar Yaw" axis from the center of the field to maximum up and down and back to the center of the field.	b. On Test Panel I-A19 vary the manual control potentiometer "Solar Yaw" from 0 volts dc to +10 volts dc to -10 volts dc and back to 0 volts dc. Vary the "Solar Focus" manual control potentiometer to maintain the solar image in focus.	b. The solar image will move from the center of the field to maximum up and down and back to the center of the field.
(3) Command reduced and then normal brightness of the solar image.	c. On Test Panel I-A19 turn the "Solar Iris" selector switch to the "Manual In" and then the "Manual Out" position.	c. The solar image brightness will be reduced and then returned to normal.
(4) Command blanking and reappearance of the solar image.	d. On Test Panel I-A19 turn the "Solar Blanking" selector switch to the "Manual Closed" and then back to the "Manual Open" position	d. The solar image will be blanked out and then reappear.
(5) On Test Panel II-A20 set the "Earth Blanking" selector switch to the "Manual Open" position.		

2-91. Reset Of Controls. The following steps are to be performed at test panel I-A19 and test panel II-A20 after functional test.

a. Depress all rate switches to the "IX" position.

b. Turn all arc lamp selector switches to the "LAMP OFF" position.

c. Turn all selector switches to the "AUTOMATIC" position.

The following instructions refer to test panel I-A19.

a. Turn the ±10 volt d-c power switch to the "OFF" position.

b. Turn the 26 volt 400 cps power switch to the "OFF" position.

2-92. RENDEZVOUS AND DOCKING EQUIPMENT MANUAL TESTS.

2-93. The following manual tests provide a complete functional check of the R&D servo systems. These tests should be performed prior to each 350 hour mission, or if a servo malfunction appears during a mission.

2-94. Manpower and Equipment Requirements. Three trained technicians (two electronic and one optical) normally perform the tests outlined here. The senior technician, electronically trained, is stationed at the electronics equipment cabinet; he functions as the commander of the test and issues the command orders. The second electronic technician is stationed in the model house; his function is to ascertain that the servo drives are functioning correctly, and to take the headings indicated by the senior technician. A third technician with optical training is stationed in the command module; this man performs the tasks necessary to determine that all the optical images are being received normally.

2-95. Pre-Test Conditions. Before starting the functional testing insure that the turn-on procedure described in paragraph 2-3 has been executed. Place all AUTO/MAN selector switches at panel 6A2A1 in the "AUTO" position. The Servo Mode indicator light located at the bottom center of panel 6A2A1 should illuminate "AUTO".

2-96. Testing Procedures. Table 2-74 outlines the commands and procedures to be followed when testing the Out-The-Window displays plus the results required to prove that the servo systems are performing normally.

Table 2-74. Out-The-Window Displays Functional Test

Command	Procedure	Result
CRT TRANSLATION WINDOW NO. 2 Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamps located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Set the 5' to 150' potentiometer to read 5'.	(2) From the command module position, the LEM should appear at a range of 5 ±2 ft. from window No. 2. Measure with a range finder (item 6, table 6-1).
	(3) Move the 5' to 150' potentiometer slowly to the 150' position.	(3) The LEM will appear to be moving away (as indicated by the range finder (item 6, table 6-1). At 150 ft. the LEM will appear at infinity.
	(4) Place the AUTO/MAN selector switch in the "MAN" position.	(4) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
CRT TRANSLATION WINDOW NO. 4 Functional Test	At test panel 6A2A1 (see figure2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamps located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Set the 5' to 150' potentiometer to read 5'.	(2) From the command module position the LEM should appear at a range of 5 ±2 ft. from window No. 4. Measure with a range finder (item 6, table 6-1).
	(3) Move the 5' to 150' potentiometer slowly to the 150' position.	(3) The LEM will appear to be moving away (as indicated by the range finder (item 6, table 6-1).
	(4) Place the AUTO/MAN selector switch in the "MAN" position.	(4) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
LENS FOCUS Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP5 (hot) and TP27 (Grd).	(2) No indication.

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
	(3) Set the 5' to 150' potentiometer to +5 ±.1 volts.	(3) In the Model House the focus servo will drive to $+89^{\circ} \pm 3^{\circ}$.
	(4) Set the 5' to 150' potentiometer to -5 ±.1 volts.	(4) In the Model House the focus servo will drive to $-89^{\circ} \pm 3^{\circ}$.
	(5) Place the AUTO/MAN selector switch in the "AUTO" position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
CAMERA CARRIAGE Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP7 (hot) and TP27 (Grd).	(2) No indication.
	(3) Set the 5' to 150' potentiometer to +5 ±.1 volts.	(3) In the Model House the camera carriage servo will drive to $+262^{\circ} \pm 6^{\circ}$.
	(4) Set the 5' to 150' potentiometer to -5 ±.1 volts.	(4) In the Model House the camera carriage servo will drive to $86^{\circ} \pm 4^{\circ}$.
	(5) Place the AUTO/MAN selector switch in the "AUTO" position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
X1 Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP9 (hot) and TP27 (Grd).	(2) No indication.
	(3) Set the 5' to 150' potentiometer to +3.11 ±.01.	(3) In the Model House the camera weight is parallel to the camera axis and pointing away from the camera.

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
	(4) Set the 5' to 150' potentiometer to -5.11 ±.01 volts.	(4) In the Model House the camera weight is parallel to the camera axis and pointing toward the camera.
	(5) Place the AUTO/MAN selector switch in the "AUTO" position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
ZETA Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP12 (hot) and TP27 (Grd).	(2) No indication.
	(3) Set the 5' to 150' potentiometer to ±5 ±.1 volts.	(3) In the Model House the Zeta servo will drive to +89° ±3°.
	(4) Set the 5' to 150' potentiometer to -5 ±.1 volts.	(4) In the Model House the Zeta servo will drive to 271° ±3°.
	(5) Place the AUTO/MAN selector switch in the "AUTO" position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MAN" to "AUTO".
ETA Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP9 (hot) and TP27 (Grd).	(2) No Indication.
	(3) Set the 5' to 150' potentiometer to +5 ±.1 volts.	(3) In the Model House the ETA servo will drive to +89° ±3°.
	(4) Set the 5' to 150' potentiometer to -5 ±.1 volts.	(4) In the Model House the ETA servo will drive to 271° ±3°.
	(5) Place the AUTO/MAN selector switch in the AUTO position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
SUN ROTATIONAL Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP18 (hot) and TP27 (Grd).	(2) No indication.
	(3) Set the 5' to 150' potentiometer to +5.11 ±.01 volts.	(3) In the Model House the Sun Rotational servo will drive to 90° ±3°.
	(4) Set the 5' to 150' potentiometer to -5.11 ±.01 volts.	(4) In the Model House the Sun Rotational servo will drive to 270 ±3°.
	(5) Place the AUTO/MAN selector switch in the AUTO position.	(5) The SERVO MODE indicator lamp located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
SUN PERIPHERY Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP5 (hot) and TP27 (Grd).	(2) No indication.
	(3) Set the 5' to 150' potentiometer to +5 ±.1 volts.	(3) In the Model House the Sun Periphery servo will drive to 88° ±3°.
	(4) Set the 5' to 150' potentiometer to -5 ±.1 volts.	(4) In the Model House the Sun Periphery servo will drive to 272° ±3°.
	(5) Place the AUTO/MAN selector switch in the "AUTO" position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
ALPHA Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
	(2) Connect a differential voltmeter (item 5, tabel 6-1) between TP23 (hot) and TP27 (Grd).	(2) No indication.
	(3) Set the 5' to 150' potentiometer to +5 ±.1 volts.	(3) In the Model House the Alpha servo will drive to +89° ±2°.
	(4) Set the 5' to 150' potentiometer to -5 ±.1 volts.	(4) In the Model House the Alpha servo will drive to -89° ±2°.
	(5) Place the AUTO/MAN selector switch in the "AUTO" position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
BETA Servo Functional Test	At test panel 6A2A1 (see figure 2-48):	
	(1) Place the AUTO/MAN selector switch in the "MAN" position.	(1) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "AUTO" to "MANUAL".
	(2) Connect a differential voltmeter (item 5, table 6-1) between TP25 (hot) and TP27 (Grd).	(2) No indication.
	(3) Set the 5' to 150' potentiometer to +5 ±.1 volts.	(3) In the Model House the Beta servo will drive to +89° ±2°.
	(4) Set the 5' to 150' potentiometer to -5 ±.1 volts.	(4) In the Model House the Beta servo will drive to -89° ±2°.
	(5) Place the AUTO/MAN selector switch in the "MAN" position.	(5) The SERVO MODE indicator lamp, located at the bottom center of panel 6A2A1, will change from "MANUAL" to "AUTO".
RASTER SIZE WINDOW NO. 2 Servo Functional Test (POSITION CONTROL)	At test panel 7A2A2 (see figure 2-41), locate the control group labeled POSITION CONTROL and proceed as follows: CAUTION Do not allow any control to remain in the extreme CW or CCW position for longer than 30 seconds.	

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
	(4) Return the RANGE control potentiometer to the DECR position.	(4) The LEM image will return to its maximum size.
	(5) Press the top half of the DISPLAY AREA/ CABINET AREA control switch.	(5) The indicator lamp incorporated with the DISPLAY AREA/CABINET AREA switch will change from "CABINET AREA" to "DISPLAY AREA".
	(6) Press the top half of the AUTO/SELECT AREA control switch.	(6) The indicator lamp incorporated with the AUTO/SELECT AREA control switch will change from "SELECT AREA" to "AUTO".

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
	CAUTION Move controls smoothly and slowly toward the extremes. A minimum of three seconds is used to move a control potentiometer from center position to stop.	
	(1) Press the bottom half of the AUTO/MANUAL selector switch located between the window 2 controls and the window 4 controls.	(1) The AUTO/MANUAL indicator lamp incorporated with the selector switch will change from "AUTO" to "MANUAL".
	(2) Rotate the AZIMUTH control slowly and evenly from the center position to the extreme "L" position.	(2) As the control is moved off-center toward the extreme left the LEM will follow, starting from the center of the window, and moving left, until it disappears out of the field of view.
	(3) Slowly return the AZIMUTH control to the center position.	(3) The LEM will appear from the left edge of the field of view and move to the center of the window.
	(4) Rotate the AZIMUTH control slowly and evenly from the center position to the extreme "R" position.	(4) As the control is moved off-center toward the extreme right, the LEM will follow, starting at the center of the window and moving right until it disappears from the field of view.
	(5) Slowly return the AZIMUTH control to the center position.	(5) The LEM will appear from the right edge of the field of view and move to the center of the window.
	(6) Rotate the ELEVATION control slowly and evenly from the center position to the extreme "UP" position.	(6) As the control is moved off-center toward the extreme "UP" position, the LEM will follow, starting from the center of the window and moving up until it disappears from the field of view.
	(7) Slowly return the ELEVATION control to the center position.	(7) The LEM will appear from the top edge of the field of view and move to the center of the window.
	(8) Rotate the ELEVATION control slowly and evenly from the center position to the extreme "DOWN" position.	(8) As the control is moved off-center toward the extreme down position, the LEM will follow, starting from the center and moving down until it disappears from the bottom of the field of view.
	(9) Slowly return the ELEVATION control to the center position.	(9) The LEM will appear from the bottom of the field of view and move to the center of the window

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
	(10) Press the top half of the AUTO/MANUAL selector switch located between the window 2 controls and the window 4 controls.	(10) The AUTO/MANUAL indicator lamp incorporated with the selector switch will change from "MANUAL" to "AUTO".
RASTER SIZE WINDOW NO. 2 Servo Functional Test (RANGE CONTROL)	At test panel 7A2A2 (see figure 2-41), locate the control group labeled RANGE CONTROL and proceed as follows:	
	(1) Press the bottom half of the AUTO/SELECT AREA control switch.	(1) The indicator lamp incorporated with the AUTO/SELECT AREA switch will change from "AUTO" to "SELECT AREA".
	(2) Press the bottom half of the DISPLAY AREA/CABINET AREA control switch.	(2) The indicator lamp incorporated with the DISPLAY AREA/CABINET AREA switch will change from "DISPLAY AREA" to "CABINET AREA".
	CAUTION Maintain a minimum brightness level during this test (maximum bias level).	
	(3) Rotate the RANGE control potentiometer from the "DECR" position to the "INCR" position slowly and evenly.	(3) At the extreme DECR position the LEM image size will be maximum. As the RANGE control is moved toward the INCR position the LEM image will become proportionally smaller, reaching its minimum size when the RANGE control indicates the "INCR" position.
	(4) Return the RANGE control potentiometer to the DECR position.	(4) The LEM image will return to its maximum size.
	(5) Press the top half of the DISPLAY AREA/CABINET AREA control switch.	(5) The indicator lamp incorporated with the DISPLAY AREA/CABINET AREA switch will change from "CABINET AREA" to "DISPLAY AREA".
	(6) Press the top half of the AUTO/SELECT AREA control switch.	(6) The indicator lamp incorporated with the AUTO/SELECT AREA control switch will change from "SELECT AREA" to "AUTO".

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
RASTER SIZE WINDOW NO. 4 Servo Functional Test. (POSITION CONTROL)	At test panel 7A2A2 (see figure 2-41), locate the control group labeled POSITION CONTROL and proceed as follows:	
	CAUTION	
	1. Do not allow any control to remain in the extreme CW or CCW position for longer than 30 seconds	
	2. Move controls smoothly and slowly toward the extremes. A minimum of three seconds is used to move a control potentiometer from center position to stop.	
	(1) Press the bottom half of the AUTO/MANUAL selector switch located between the window 2 controls and the window 4 controls.	(1) The AUTO/MANUAL indicator lamp incorporated with the selector switch will change from "AUTO" to "MANUAL".
	(2) Rotate the AZIMUTH control slowly and evenly from the center position to the extreme "L" position.	(2) As the control is moved off-center toward the extreme left the LEM will follow, starting from the center of the window, and moving left, until it disappears out of the field of view.
	(3) Slowly return the AZIMUTH control to the center position.	(3) The LEM will appear from the left edge of the field of view and move to the center of the window.
	(4) Rotate the AZIMUTH control slowly and evenly from the center position to the extreme "R" position.	(4) As the control is moved off-center toward the extreme right, the LEM will follow, starting at the center of the window and moving right until it disappears from the field of view.
	(5) Slowly return the AZIMUTH control to the center position.	(5) The LEM will appear from the right edge of the field of view and move to the center of the window.
	(6) Rotate the ELEVATION control slowly and evenly from the center position to the extreme "UP" position	(6) As the control is moved off-center toward the extreme "UP" position, the LEM will follow, starting from the center of the window and moving up until it disappears from the field of view.

Table 2-74. Out-The-Window Displays Functional Test (Cont)

Command	Procedure	Result
	(7) Slowly return the ELEVATION control to the center position.	(7) The LEM will appear from the top edge of the field of view and move to the center of the window.
	(8) Rotate the ELEVATION control slowly and evenly from the center position to the extreme "DOWN" position.	(8) As the control is moved off-center toward the extreme down position, the LEM will follow, starting from the center and moving down until it disappears from the bottom of the field of view.
	(9) Slowly return the ELEVATION control to the center position.	(9) The LEM will appear from the bottom of the field of view and move to the center of the window.
	(10) Press the top half of the AUTO/MANUAL selector switch located between the window 2 controls and the window 4 controls.	(10) The AUTO/MANUAL indicator lamp incorporated with the selector switch will change from "MANUAL" to "AUTO".
RASTER SIZE WINDOW NO. 4 Servo Functional Test (RANGE CONTROL)	At test panel 7A2A2 (see figure 2-41), locate the control group labeled RANGE CONTROL and proceed as follows:	
	(1) Press the bottom half of the AUTO/SELECT AREA control switch.	(1) The indicator lamp incorporated with the AUTO/SELECT AREA switch will change from "AUTO" to "SELECT AREA".
	(2) Press the bottom half of the DISPLAY AREA/CABINET AREA control switch.	(2) The indicator lamp incorporated with the DISPLAY AREA/CABINET AREA switch will change from "DISPLAY AREA" to "CABINET AREA".
	CAUTION Maintain a minimum brightness level during this test (maximum bias level).	
	(3) Rotate the RANGE control potentiometer from the "DECR" position to the "INCR" position slowly and evenly.	(3) At the extreme DECR position the LEM image size will be maximum. As the RANGE control is moved toward the INCR position the LEM image will become proportionally smaller, reaching its minimum size when the RANGE control indicates the "INCR" position.

SECTION III

TROUBLE ANALYSIS

3-1. GENERAL.

3-2. The visual system is designed for rapid detection and repair of malfunctioning subassemblies. The majority of equipment malfunctions can be quickly traced to a subassembly by performing routine or manual checks.

3-3. This section contains a table of possible malfunctions which could be detected by the tests performed in Section II. The table is arranged by simulator areas and list the simulator subsystem, trouble, probable cause, and suggested procedural remedy. Where a system is comprised of various components, a trouble analysis is given for the complete system with trouble analysis for the various components following. Preliminary information is also provided, where necessary, in paragraph form preceding the trouble analysis table. Notes, cautions, and warnings appear throughout both the text and the tables, and should be heeded for proper protection of the equipment and personnel.

3-4. TELESCOPE AND SEXTANT TROUBLE ANALYSIS.

3-5. Various malfunctions which might occur in the telescope and sextant systems are covered in following paragraphs. Actual repair and calibration of the equipment is included in separate sections.

3-6. TELESCOPE.

3-7. Malfunctions in telescope performance can be of two types, in the following order of probability:

a. Failure of an operable component to respond to signals transmitted from the computer complex via the electronics cabinet's amplifier.

b. An optically incorrect image of a correctly generated scene, as observed through the telescope's eyepiece.

Troubleshooting for an electrical or electro-mechanical malfunction is tabulated in table 3-7. The possible causes and remedial actions are listed in the order that will facilitate correction of the malfunction most rapidly.

3-8. An optical malfunction, as described in b. above, must be corrected by performing the optical alignment procedure described in Section VI. The positioning of the MEP and the celestial sphere to provide the correctly generated scene referred to is covered in Section IV.

3-9. SEXTANT.

3-10. Malfunctioning of the sextant may be categorized in two classifications, in the order of probability:

a. Malperformance caused by an electrical/electronic or an electromechanical failure in an operable assembly, and;

b. Malperformance caused by optical misalignment resulting from, again in the order of probability:

(1) A displacement, or deflection, of a true optical path by reason of a malfunction or improper positioning of a component incorporating optical elements: starfield generator assembly, starfield and landmark rhomb scanners, landmark variable magnification assembly, rotating polaroid assembly, rotating reticle assembly, or rotating prism assembly. Incorrect landmark slide positioning is another possible cause.

(2) A displacement, or deflection, of a true optical path by reason of the improper positioning of a fixed optical assembly: starfield navigational star beamsplitter, starfield relay lens assembly, starfield landmark combining beamsplitter, right angle and compound mirrors, eyepiece tube relay lens, or eyepiece assembly.

3-11. With reference to paragraphs 3-10a. above, troubleshooting should be performed in a sequence that will eliminate as many causes as possible before removing the sextant cover or any of the cover panel sections. Table 3-2 lists the electrical connections for the various operable assemblies and light sources from the electronics cabinet connectors to the sextant connectors and finally, to the terminal boards. The locations of terminal boards 12TB1 through 12TB8 and 12TB13 are illustrated in figure 4-11; the locations of all fourteen terminal boards are described in table 3-3. The locations of the sextant connectors are illustrated in figure 1-11 and figure 1-12. Table 3-3 is not to be considered as a listing of malfunctions, possible causes, or remedial actions. It is intended to serve as a guide line for trouble analysis.

3-12. OPTICAL MISALIGNMENT. Referring to subparagraph 3-10b; an optical misalignment caused by the improper positioning of an assembly, either operable or fixed, may be the result of a replacement procedure. Realignment instructions to be performed in such instances are contained in Section VI.

3-13. Another possible cause for optical misalignment over a long period of time is plastic metal flow, or cyrstalline growth, resulting in metal deformation. Such misalignment could be compensated for by adjustment of the rhomb scanner assemblies, following an engineering analysis of the problem.

3-14. Locating Cause of Malfunction. For the pin-pointing of malfunction possible causes, as listed in table 3-7, the first requirement is that the sextant and the electronics cabinet test panel be placed in the test mode of operation. Refer to Section II of this manual for instructions.

3-15. TELESCOPE AND SEXTANT POWER SUPPLIES.

3-16. Power is provided to the sextant and telescope by four Trygon power supplies. Trouble analysis for these units is given in paragraph 3-35.

3-17. OUT THE WINDOW DISPLAYS.

3-18. Continued operation of the visual system requires the conducting of maintenance operations by teams of optical, mechanical and electrical specialists. The following paragraphs and charts provide recommended procedures for optical and mechanical specialist teams.

3-19. GENERAL OPTICAL TROUBLE ANALYSIS.

3-20. The visual system's operation depends upon the optical functioning of lens, mirror, and beamsplitter surfaces described in Section I. Since these surfaces are mounted within an air filtered building and further enclosed within the metallic housing of the visual system itself, they are protected to a large degree. Despite these protective measures, time results in the gradual deposition of two types of airborne contaminations upon the optical surface; namely, dust and grease type transluscent coating. Upon close examination of the laterally illuminated optical surface, both types of deposits may be apparent to the eye before the deposit accumulates sufficiently to become an exit pupil impairing deposit. Exceptions of this are the beamsplitter No. 1, the C/S input surface, the MEP input screen, and the TV input screen. deposits on these surfaces readily manifest themselves in the exit pupil images, since these surfaces constitute optical object for the subsequent optical systems.

3-21. The cleaning of optical surfaces should never be authorized on a periodic basis, nor even when close inspection of an optical surface reveals considerable deposits of dust and grease. On the contrary, a clear distinction must be born in mind between mere optical surface deposits, and exit pupil image impairing deposits. Exit pupil image impairing deposits constitute a trouble which can be corrected through painstaking application of the normal troubleshooting routine.

3-22. The application of this general troubleshooting routine to the problems attendant upon the occurrence of exit pupil image impairing deposits involves: location, cleaning, and examining. The presence of exit pupil image impairing deposits may be assumed probable in cases wherein a particular exit pupil image remains apparent and constant regardless of changes in the pattern generated by a particular input generator.

3-23. Location Of Surface To Be Cleaned. Determination of the most probable location of a particular exit pupil image impairing deposit will be facilitated by referring to figure 1-30 and applying the following trouble diagnosis and symptom diagnosis procedures:

a. Exit pupil image impairing deposits occur readily upon the capsule window since its surface is exposed to accidental contact by hands, greased hair, etc.

b. Exit pupil image impairing deposits occur with considerable frequency upon the surfaces of the No. 1 beamsplitter since the interception of this beamsplitter surface by the common focal surface causes contaminants deposited near this line of interception to appear in good focus. Deposits at a distance from this line of interception will appear in poor focus.

3-24. The No. 1 beamsplitter should be cleaned immediately after the cleaning of the capsule window. Cleaning of this element is particularly warranted in the event of detection of contaminants upon its laterally illuminated surface. If the cleaning fails to eliminate the appearance of all exit pupil image impairing deposits, the search for the location of the contamination should be extended to include the following diagnostic considerations.

a. Exit pupil image impairing deposits located on either the TV input screen or the MEP input screen manifest themselves via an exit pupil image of the actual deposit which appears sharp and clear since these screens are the object planes of the TV input optical projection system and the MEP input optical projection system. Determination of the particular input bearing the exit pupil image impairing deposit may be facilitated by the sequential turning on and off of first the TV input tube and then the MEP input.

b. Exit pupil image impairing deposits located upon all optical elements excepting the input surfaces, and in some cases beamsplitter No. 1, will manifest themselves via an exit pupil image which causes the actual image to appear as seen through a haze or fog. This is caused because these surfaces are sufficiently removed from the object plane of the three optical projection systems, comprising the window optical system, as to preclude the sharp imaging of these deposits. The horizontal mirror and beamsplitters are particularly prone to deposition of exit pupil image impairing deposits.

c. Exit pupil image impairing deposits located upon the optical surfaces of the C/S illumination assembly and earth/moon occultation system will appear as a "blinking star effect". The luminosity of stars of the celestial sphere will appear to suddenly decrease and then suddenly increase as they pass through the deposit occulted region of the cone of illumination. The illumination assembly mirror surfaces should be cleaned first, with subsequent cleaning of the lens surfaces and the surface of the OSRAM lamp.

d. Exit pupil image imparing deposits (in the form of reflective dust and grease deposits) upon the black or reflecting surfaces of the C/S will cause a decrease in the contrast of the reflective bearing balls with respect to the black background. Since contrast is a function of the total utilized illumination, the time when cleaning is necessary should be considered as the time that the operator is forced to increase the lamp voltage to obtain adequate contrast. Another symptom is the appearance of the "feed in length" of the tape as a silhouette against the C/S. This appearance of the "feed in length" against the C/S is caused by the higher reflective properties of the deposits which settle on the celestial sphere, thus causing the sphere to turn from black to grey.

e. Exit pupil image impairing deposits on the tape of the star background occulating assembly will be noticed when dust collects on the tape in sufficient quantity to cause each consecutive tape layer from lying in complete contact with tis adjacent layer during wind up. The "shine through" phenomena may appear even with a clean tape. This is caused by failure of the tape drives to apply adequate tension to the tape and should be referred to electrical maintenance personnel.

3-25. CELESTIAL SPHERE TROUBLE ANALYSIS.

3-26. Failure of the servo system to respond to a particular control operation is an indication of a malfunction. After insuring that all controls are in their proper operaing positions, check to insure that all corresponding indicator lamps are illuminated. In the event a lamp fails to light, check the lamp and associated fuses. Malfunctions persisting throughout the use of this simple electrical check of lamps and fuses should result in a careful diagnosis by use of the trouble analysis table.

3-27. Prior to the start of troubleshooting it is essential to insure that the input and output signal leads of the d-c preamplifiers AR1, AR2 and AR5 are isolated from the case or chassis ground. Also, insure that the 100 watt power amplifier and 300 watt Inland Control roll axis power amplifiers are isolated from chassis ground.

CAUTION

1. In no case should any of these leads be grounded. Serious damage to the units can result. In monitoring any signal with an oscilloscope, special care should be taken to insure that the oscilloscope return lead is not at chassis ground potential.

2. It should be noted that the transistors Q1, Q2, Q3, Q4, Q5, and Q6 are heatsinked (mica washers) to the C/S A1 electronics chassis with their cases at collector potential of 28 volts dc. Care should be exercised not to ground the cases to the chassis. This may result in the 28 volt supply shorting to ground.

3-28. OUT OF THE WINDOW DISPLAY POWER SUPPLIES.

3-29. Trouble analysis for all power supplies providing power to the MEP or celestial sphere (with the exception of the Trygon power supplies covered in paragraph 3-35) are present in table 3-7, unit No. 11.

3-30. RENDEZVOUS AND DOCKING DISPLAYS TROUBLE ANALYSIS.

3-31. Malfunctions in R & D equipment performance can be of two types, in the following order of probability:

a. Failure of an operable component to respond to signals transmitted from the computer complex via the electronics cabinet's amplifier.

b. An optically incorrect image of a correctly generated scene, as observed at the R & D window.

Troubleshooting for an electrical or electro-mechanical malfunction is tabulated in table 3-7, unit No. 18. The possible causes and remedial actions are listed in the order that will facilitate correction of the malfunction most rapidly.

3-32. An optical malfunction, as described in b. above, must be corrected by performing the optical alignment procedure described in Section VI.

3-33. RENDEZVOUS AND DOCKING EQUIPMENT POWER SUPPLIES.

3-34. Trouble analysis for all power supplies providing power to the rendezvous and docking equipment (with the exception of the Trygon power supplies covered in paragraph 3-35) is presented in table 3-7, unit No. 18.

3-35. TRYGON POWER SUPPLIES.

3-36. GENERAL

3-37. The trygon power supplies used in the AMS are precision instruments and should be servied by experienced maintenance personnel. To isolate defects, when a system malfunction appears to be caused by the power supply, proceed as follows:

a. Disconnect all loads and interconnecting wiring.

b. Check that the shorting links are in place across terminals 1 and 2, 3 and 4, and 6 and 7. Insure that all connections are clean and tight.

c. Make sure that the Master-Slave switch is in the "master" position.

d. Connect a resistor load across the output terminals, and operate the power supply to determine if the unit is functioning properly.

e. If the power supply is malfunctioning refer to units 50 through 54 of the touble-analysis table.

f. If the power supply appears normal, repeat steps a. through e. on all interconnected power supplies affecting the system.

3-38. TROUBLESHOOTING.

3-39. Troubleshooting of the Trygon power supplies is accomplished by using the touble analysis chart and the voltage lists provided. The following general procedures are given to aid in the efficient maintenance and repair of the power supplies.

a. Voltage measurements are made with a voltmeter (item 1, table 3-1), vacuum tube volt-ohmmeter (item 4, table 3-1), or oscilloscope (item 2, table 3-1).

b. Voltages called out are nominal and can vary ±5%.

c. Transistors should be tested on a transistor test set (item 3, table 3-1), or if the equipment is not available, with the ohm-meter section of a vacuum tube volt-ohmmeter.

d. Diodes and rectifiers should be tested with the ohmmeter section of a vacuum tube volt-ohmmeter.

e. Unless otherwise specified, the Voltage Adjust control and the Voltage Vernier control should be at the fully clockwise position for troubleshooting procedures.

f. Insure that the shorting links are in place on the rear barrier strip. Shorting links should be between terminals 1 and 2, terminals 3 and 4, and terminals 6 and 7.

g. Check to insure that all fuses are good and all Zener diodes used are within ±5% fo the values indicated on the power-supply schematic.

h. If a malfunction occurs when the power supply is in the "current" mode, it is recommended that troubleshooting procedures first be carried out in the "voltage" mode.

i. When malfunctions of an intermittent nature occur, such as poor regulation, ripple, etc., use an oscilloscope to determine dynamic changes in the power-supply circuitry.

j. If voltage checks fail to show the cause of the malfunction, disconnect power and proceed with a point to point resistance check of potentiometers, switches, diodes, resistors, and transistors in that order.

3-40. POWER SUPPLIES. Thirteen power supplies furnish the AMS with d-c voltages from 0 volts dc to plus and minus 325 volts dc. The power supplies are listed by their location in table 3-4.

3-41. When a malfunction occurs in one of these units, perform the check out procedures given in paragraph 3-38.

WARNING

Harmful voltages are present in these units. Discharge all capacitors before servicing.

Visually inspect the unit for broken or loose connections, frayed wires, worn insulation, dirt, bad or "cold"solder joints, and other obvious defects which might impair operation. Check fuses for continuity then proceede with the trouble analysis chart, table 3-7.

NOTE

Observe the proper polarity when checking power supply voltages, polarities may be obtained from the schematic diagrams in Section VIII. The base to emitter voltages of all transistors in the series regulator should be negative for conduction.

Table 3-1. Test Equipment

Item	Nomenclature	Specification
1	Oscilloscope Textronix 585A	
2	Voltmeter, Vacuum Tube Simpson Model 269	20,000 Ohms per Volt - DC 5,000 Ohms per Volt - AC
3	Differential Voltmeter John Fluke Model 323A/AG	
4	Frequency Counter	
5	Pressure Gage, Wallace & Tiernan FA233	Range - 0 to 50 psia Accuracy - ±0.05 psia
6	Signal Generator Model HP 200 CD	Range 88kc to 440mc; to 110mc on fundamentals
7	AC Voltmeter, Ballantine 400 K	
8	Milliammeter	
9	Gram Gage, C	
10	Spring Balance Scale, Chatillon Spring Pull	Range - 0.25 pounds
11	Square Wave Generator, Fairchild 971	
12	D.C. Voltmeter Fluke 823B	
13	Galvanometer	
14	Potentiometer (divider)	
15	Multimeter	

Table 3-2. Sextant Assemblies Electrical Connections

Component	Long Wire No.	Electronics Cabinet Connector and Pin No.	Sextant Connector and Pin No.	Terminal Board Connections
Combined Light Source, Landmark and Starfield				
Starfield lamp	W538	9J1-a, e	12J1-a, e	12TB14 via 12TB12-1, 2
Landmark lamp	W538	9J1-Y, h	12J1-Y, h	12TB14 via 12TB12-4, 5
Starfield and Landmark lamps ventilating fans	W538	9J1-n, j	12J1-n, j	12TB14 via 12TB12-11, 12
Landmark lamp test switch	N/A	N/A	N/A	12TB14 via 12TB12-4, 5
Carousel and Slide Actuator Assembly				
Carousel motor-generator	W538	9J1-K, O	12J1-K, O	12TB10-11, 12
Tachometer	W538	9J1-U, Z, d, k	12J1-U, Z, d, k	12TB10-8, 9, 10, 13, 14, 17, 18
Resolver	W538	9J1-F, A, C, H, L, V, P	12J1-F, A, C, H, L, V, P	12TB10-1, 2, 3, 4, 5, 6, 7
Slide actuator motor	W538	9J1-n, j	12J5-L, K via 12J1-n, j	12TB11-2, 3, 4
Slide in out limit switches	N/A	N/A	N/A	12TB11-2, 3, 4, 5, 6, 7, 8

Table 3-2. Sextant Assemblies Electrical Connections (Cont)

Component	Long Wire No.	Electronics Cabinet Connector and Pin No.	Sextant Connector and Pin No.	Terminal Board Connections
Landmark Rhomb Scanner				
Alpha rhomb motor	W540	9J3-v, z	12J3-v, z	12TB6-17, 18
Alpha 1X resolver	W540	9J3-B, E, G, J, N, T, x	12J3-B, E, G, J, N, T, x	12TB6-1, 2, 3, 4, 5, 6, 7
Alpha 32X resolver	W540	9J3-w, b, f, k, g, m, p	12J3-w, b, f, k, g, m, p	12TB6-8, 9, 10, 11 12, 13, 14
Alpha limit switches	N/A	N/A	N/A	12TB6-17, 18
Beta rhomb motor	W540	9J3-u, x	12J3-u, x	12TB7-3, 4
Beta 1X resolver	W540	9J3-Y, U, O, H, F C, A	12J3-Y, U, O, H, F C, A	12TB7-7, 8, 9, 10, 11, 12, 13
Beta 32X resolver	W540	9J3-r, h, n, j, d, Z, P	12J3-r, h, n, j, d, Z, P	12TB7-14, 15, 16, 17, 18, 19, 20
Beta limit switches	N/A	N/A	N/A	12TB7-3, 4
Variable Magnification				
Motor-generator	W538	9J1-N, T	12J1-N, T	12TB8-12, 13
Tachometer	W538	9J1-k, p, X, b, g	12J1-k, p, X, b, g	12TB8-14, 15, 16, 18, 19, 20
Resolver	W538	9J1-B, F, G, J, M, S, W	12J1-B, F, G, J, M, S, W	12TB8-3, 4, 5, 6, 7, 8, 9
Limit switches	N/A	N/A	N/A	12TB8-12, 13

Table 3-2. Sextant Assemblies Electrical Connections (Cont)

Component	Long Wire No.	Electronics Cabinet Connector and Pin No.	Sextant Connector and Pin No.	Terminal Board Connections
Rotating Polaroid				
Drive motor	W541	9J4-w, y	12J4-w, y	12TB4-12, 13
Resolver	W541	9J4-W, b, f, k, Z e, j	12J4-W, b, f, k, Z e, j	12TB4-5, 6, 7, 8, 9 10, 11
Starfield Generator				
Starfield selector motor	W540	9J3-w, y	12J3-w, y	12TB13-8, 9
Resolver	W540	9J3-I, L, M, R, V, a, e	12J3-I, L, M, R, a, e	12TB13-1, 2, 3, 4, 5, 6, 7
Starfield rotational motor	W539	9J2-w, y	12J2-w, y	12TB13-18, 19
Resolver	W539	9J2-I, L, M, R, V, a, e	12J2-I, L, M, R, V, a, e	12TB13-11, 12, 13, 14, 15, 16, 17
Navigational star light source	W538	9J1-a, e	12J1-a, e	12TB12-18, 19 via XFMR
Starfield Rhomb Scanner				
Alpha rhomb motor	W539	9J2-v, z	12J2-v, z	12TB2-17, 18
Alpha 1X resolver	W539	9J2-B, E, G, J, N, T, x	12J2-B, E, G, J, N, T, x	12TB2-1, 2, 3, 4, 5, 6, 7
Alpha 32X resolver	W539	9J2-w, b, P, R, g, m, p	12J2-w, b, P, R, g, m, p	12TB2-8, 9, 10, 11 12, 13, 14

Table 3-2. Sextant Assemblies Electrical Connections (Cont)

Component	Long Wire No.	Electronics Cabinet Connector and Pin No.	Sextant Connector and Pin No.	Terminal Board Connections
Starfield Rhomb Scanner (Cont)				
Alpha limit switches	N/A	N/A	N/A	12TB2-17, 18
Beta rhomb motor	W539	9J2-u, x	12J2-u, x	12TB5-3, 4
Beta 1X resolver	W539	9J2-Y, U, O, H, F, C, A	12J2-Y, U, O, H, F, C, A	12TB5-7, 8, 9, 10, 11, 12, 13
Beta 32X resolver	W539	9J2-r, n, h, j, d, Z, P	12J2-r, n, h, j, d, Z, P	12TB5-14, 15, 16, 17, 18, 19, 20
Beta limit switches	N/A	N/A	N/A	12TB5-3, 4
Rotating Reticle				
Pancake torque motor	W541	9J4-v, z	12J4-v, z	12TB3-12, 13
Pancake resolver	W541	9J4-B, E, G, N, T	12J4-B, E, G, N, T	12TB3-5, 6, 7, 8, 9, 10
Edge lights (4)	W538	9J1-c, m	12J1-c, m	12TB3-1, 2, 3, 4
Rotating Prism				
Pancake torque motor	W541	9J4-y, u	12J4-y, u	12TB9-1, 2
Pancake resolver	W541	9J4-A, C, F, K, O	12J4-A, C, F, K, O	12TB9-3, 4, 5, 6, 7, 8
Sunshafting Lamp	W538	9J1-D, I	12J1-D, I	12TB4-1, 2

Table 3-3. Terminal Board Locations

T.B. No.	Location
12TB1	On starfield side of optical bed plate, parallel to the side and adjacent to the starfield generator assembly.
12TB2	On starfield side of optical bed plate, perpendicular to the side and immediately forward of the starfield rhomb scanner assembly.
12TB3	On starfield side of optical bed plate, parallel to the forward end and adjacent to the starfield right angle mirror and compound angle mirror.
12TB4	Longitudinally central on optical bed plate, perpendicular to the sides and adjacent to the landmark/starfield beam-splitter and the landmark right angle mirror base.
12TB5	Longitudinally central on optical bed plate, parallel to the sides and immediately forward of landmark rhomb scanner assembly.
12TB6	Mounted on top cover plate of the landmark rhomb scanner assembly.
12TB7	On landmark side of optical bed plate, parallel to the side and adjacent to the aft end of the variable magnification assembly.
12TB8	On landmark side of optical bed plate, parallel to the side and adjacent to the forward end of the variable magnification assembly; forward of 12TB7.
12TB9	Mounted on inner surface of the box-section rotating prism assembly housing.
12TB10	Mounted on frame-supported plate between carousel and the optical bed plate, parallel to the bed plate.
12TB11	Mounted similarly and adjacent to 12TB10.

Table 3-3. Terminal Board Locations (Cont)

T.B. No.	Location
12TB12	Mounted on rear channel member of carousel portion of the support frame; inner surface of channel web.
12TB13	Mounted on top of the starfield rhomb scanner assembly; serves as jumper connection between 12TB1 and the starfield generator assembly.
12TB14	Mounted inside the landmark side of the combined light source assembly.

Table 3-4. Power Supply Locations

Power Supply	Location	Quantity/Unit	Voltage
437178	Unit 6	2	±50 vdc
437684	Unit 6	2	±30 vdc
	Unit 10	1	+28 vdc
	Unit 70	1	+28 vdc
	Unit 71	1	+28 vdc
	Unit 72	1	+28 vdc
	Unit 73	1	+28 vdc
437180	Unit 8	2	±300 vdc
437681	Unit 6	2	±10 vdc

Table 3-5. Power Supply Voltages

Power Supply	Across	DC Voltage Reading ±10%
437178	C2	30
	CR7, CR8, CR9	2.4
	R5	5.7
	CR10	6.5
	R7	5.9
	C4	15
	CR17	0.6
	R24	4.8
	R22	6.8
	C2	30
	CR7, CR8, CR9	2.4
	R5	5.7
	CR10	6.5
	R7	5.9
	C4	15
	CR17	0.6
	R24	4.8
	R22	6.8
	R100, R20	4.8
	R21	4.8
	R25	8.2
	CR40	0.6
	R28	6.2
	R30	7.5
	R31	6.9
	C9	170-200
	C20	170-200
	CR50	5.1
	CR28, CR30	1.2
	CR25	0.6
	CR27	0.6
	R101	15
	R102	15
	CR24	160 (output voltage)
437684	C1, C2, C3	60
	C11	14.5
	CR23	5.1
	CR30	9.6
	CR31	6.1
	CR36	5.1
	CR44	15
	CR46	5.1
	R59	0.45

Table 3-5. Power Supply Voltages (Cont)

Power Supply	Across	DC Voltage Reading ±10%
437684 (Cont)	R153	0.2
	R155	0.45
437180	C7	28
	C1	370
	CR13	15
	CR14	9.7
	C12	28
	R49	14
	R57	8.9
	R61	3.2
	Q25 Emitter to Collector	7.7
	R44	0
	CR18	300 (output voltage)
	R59	9.0
	R67	25
437681	C2	30
	CR7, CR8	2.4
	R5	5.7
	CR10	6.5
	R7	5.9
	C4	15
	CR17	0.6
	R24	4.8
	R21	4.8
	R25	8.2
	CR30	0.6
	R28	6.2
	R30	7.5
	R31	6.9
	C9	20-40
	CR50	5.1
	CR28 and CR40	1.2
	CR25	0.6
	CR26	0.6
	R101	15
	R102	15
	C22	36 (output voltage)

Table 3-6. Trouble Analysis Items

Unit No.	Item
1	Telescope
2	Sextant Servo Systems
3	Sextant Landmark Scene Generation
4	Sextant Landmark and Starfield Rhomb Scanners
5	Sextant Starfield Generation
6	Sextant Landmark Variable Magnification
7	Sextant Rotating Reticle Assembly
8	Sextant Sunshafting Effect
9	Out The Window Optical System
10	C/S Pitch Axis
11	C/S Yaw Axis
12	C/S Roll Axis
13	MEP Optical System
14	MEP DC Servos
15	MEP AC Servos
16	MEP Dual Speed AC Servos
17	MEP D.C. Drive
18	MEP Solenoid Drive
19	Out The Window High Power DC Amplifier
20	Out The Window Mission Film Power Supply
21	Out The Window Trans-Boundary Power Supply
22	Out The Window 400 Watt Solar Power Supply
23	R/D Model, Target Vehicle - Gimbal Mounted
24	R/D Model, Viewing Closed-Loop Television System
25	R/D Model, Viewing Closed-Loop Television System Oscillator Drive, Module 8A2A5
26	R/D Model, Viewing Closed-Loop Television System Binary Divider Module 8A2A5
27	R/D Model, Viewing Closed-Loop Television System Sync Generator Module 8A2A5
28	R/D Model, Viewing Closed-Loop Television System Power Regulator Module 8A2A5
29	R/D Model, Viewing Closed-Loop Television System Bias Supply 8A2A5
30	R/D Slide Viewing Closed-Loop Television System
31	R/D Slide Viewing Closed-Loop Television Sweep Circuits 7A1A4, 7A2A5, and 7A2A7
32	R/D Slide Viewing Closed-Loop Television System Camera Blanking and Dynamic Focus
33	R/D Slide Viewing CC TV Camera Video Circuits
34	R/D Slide Viewing Closed-Loop Television System Vidicon Camera Tube

Table 3-6. Trouble Analysis Items (Cont)

Unit No.	Items
35	R/D Waveform Monitor (7A2A3)
36	R/D ETA Servo
37	ZETA Servo
38	R/D XI Vehicle Drive Assembly
39	R/D XI Servo
40	R/D Rotational Sun Track Drive
41	R/D Sun Rotational Servo
42	R/D Peripheral Sun Drive
43	R/D Sun Periphery Servo
44	R/D Alpha Servo
45	R/D Beta Servo
46	R/D Camera Carriage Servo
47	R/D Camera Focus Servo
48	R/D CRT Translation Servo-Window No. 2
49	R/D CRT Translation Servo-Window No. 4
50	R/D Raster Size Servo-Window No. 2
51	R/D Raster Size Servo-Window No. 4
52	-150 Volt Power Supply 7A1A4, 7A2A5
53	R/D Voltage Regulator 8A2A9
54	R/D GPL +300 Volt Power Supply 8A2A4 and 8A2A5
55	R/D +900 Volt Power Supply 7A1A4 and 7A2A5
56	Trygon Power Supplies - Servos
57	Trygon Power Supply 437178
58	Trygon Power Supply 437684
59	Trygon Power Supply 437180
60	Trygon Power Supply 437681

Table 3-7. Trouble Analysis

Unit	Trouble	Probable Cause	Procedure/Remedy
1. Telescope	a. Uneven, or lack of reticle edge illumination.	(1) Loose or open connections on terminal board 13TB2.	(a) Tighten edge light connections. See rotating reticle and sunshafting wiring data (Table 1-2).
		(2) Electrical failure in reticle lighting circuitry.	(a) Check circuitry in unit 10.
		(3) Broken lead in cable W542.	(a) Perform continuity test for applicable leads in W542. Transfer one of the spare leads provided to applicable pins at both ends of cable. If broken lead is discovered, see Table 1-2 for pin destinations.
		(4) Burned out reticle edge lighting lamp(s).	(a) Remove reticle assembly and replace lamp(s).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
1. Telescope (Cont)	b. Reticle fails to rotate in response to command signals; fails to rotate smoothly, or position within required accuracy of ±0.5°.	(1) Loose or open connections on terminal board 13TB2 or 13TB3.	(a) Inspect and tighten loose connections. Refer to table 1-2.
		(2) Incorrect signal transmission from electronics cabinet.	(a) Check-out rotating reticle electronics.
		(3) Broken leads in cable W543.	(a) Refer to 1a (3) (a) for procedure.
		(4) Malfunctioning of electrical component in rotating reticle assembly.	(a) Replace assembly with spare, followed by zeroing procedure.
	c. Occulting blade(s) fail to respond to	(1) Incorrect signal transmission from electronics cabinet.	(a) Check electronics cabinet for malfunctioning blade(s).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
1. Telescope (Cont)	command signals; fail to occult smoothly, or fail to position within the required ±3 degrees accuracy, as measured by the fiducial markings on the reticle.		
		(2) Broken leads in cable W542.	(a) Refer to 1a (3) (a). See Table 1-2 for pin connections.
		(3) Loose or open terminal connections on 13TB4, 13TB5 or 13TB6.	(a) Remove occulting assembly from reticle, occulting and lens assembly casting to check for loose terminal board connections.
		(4) Malfunctioning of electrical component in occulting assembly.	(a) Refer to 1c (3) (a).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
1. Telescope (Cont)	d. Sunshafting effect lamp fails to respond to signals from computer.	(1) Loose or open connections on terminal board 13TB2.	(a) Tighten connections 13TB3-7 and 8.
		(2) Incorrect signal transmission from electrical cabinet.	(a) Check power control panel circuitry in electronics cabinet Unit 10.
		(3) Burned out sunshafting lamp in Lens and Mirror housing assembly.	(a) Remove sunshafting lamp assembly and replace lamp.
		(4) Broken lead(s) in cable W542.	(a) Refer to 1a (3) (a). See Table 1-2 for pin designations.
2 Sextant Servo Systems	a. Servo is apparently open loop. Output member of servo does not respond to input command and exhibits no torque stiffness. Output member may be placed	(1) Power Supply voltages are not present or are present but not of correct value.	(a) Check that power supply voltages are present at terminal strip directly in front of electronics assembly controlling servo in question.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo System (Cont)	in any given position with servo exhibiting no resistance to motion other than weight or frictional force of coupled load.		
		(2) Break in servo signal transmission path. Causes are: an actual physical break in one or more of signal control wires for given servo, a connector not securely installed, a terminal strip not securely tightened, the TEST/NORM switch in "NORM" position and no input signal being applied (either due to three signal input connectors being removed or a failure in equipment providing input signals), or the failure of 400 cycle power supply or distribution system.	(a) Check connector installation. (b) Tighten as required. (c) Check switch setting and set switch properly. (d) Check 400-cycle power as follows: For d-c servos, measure the voltage between appropriate terminals on terminal strip in front of d-c torque motor electronics enclosure.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo Systems (Cont)			(e) For a-c servos, check that reference voltage is applied to both the motor reference winding and the tachometer reference winding on the motor tachometer unit.
		(3) Loop gain control turned down to zero gain position on electronics assembly associated with servo loop in question.	(a) Advance control to appropriate position.
	b. Servo is open loop and output member is aganist its stop in case of limited motion servos or is rotating continuously in case of unlimited rotation servos.	(1) For continuous rotation servos, problem is due to spurious input signal to servo or some malfunction in electonics assembly.	(a) For d-c servos of this type, check negative power supply and components supplying negative output. For spurious input signals, check that terminals A and B on d-c torque motor electronics assembly are shorted when unit is being used to power a single speed servo. For a-c servos, condition can only occur as result of wiring fault or resolver failure (since

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo Systems (Cont)			setting appropriate TEST/NORM switch at TEST and adjusting manual director to supply valid angular command. Because of protective end stop circuitry employed on two speed scanning servos, it may be difficult to recognize condition until scanning sector gear is lifted off its stop. WARNING Care should be exercised in this operation to avoid injury to operator.
	c. Servo appears to be operating, but on inspection it is found to have little torque stiffness and to operate sluggishly with relatively large error.	(1) Power supply voltages are not present or are not of correct value.	(a) Check power supply voltages at terminal strip directly in front of electronics assembly.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo Systems (Cont)		(2) Servo electronics assembly defective.	(a) Replace with spare.
		(3) Signal wiring broken or defective.	(a) Turn off all power to electronics cabinet. (b) Switch off power supplies powering servo in question, using switch or circuit breaker in front of power supply itself. (c) Switch off 60-cycle power and then 400-cycle power. This will disable servo in question but still leave signal circuits active. (Same result can be obtained by removing connector from front of electronics assembly powering servo in question.)

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo Systems (Cont)			(d) Connect voltmeter to test points on section of test panel associated with servo in question. (e) Set TEST/NORM switch at "TEST" and slowly rotate director. As director is rotated in one direction, voltage indicator should rise and fall in sinusoidal fashion. For some setting of director, it should be possible to obtain null of less than 0.1 volt. At its peak, voltage should rise to approximately 20 to 28 volts for all servos except telescope reticle servo, sextant reticle servo, and sextant rotating prism servo. For these servos, maximum voltage to be obtained is between four and six volts.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo Systems (Cont)			NOTE If above results cannot be obtained or if null voltage is relatively high or indistinct, wiring associated with servos is most likely defective. (f) For a more complete check for wiring continuity, above procedures should be repeated with voltmeter connected to error terminals on terminal strip directly in front of electronics assembly associated with servo in question. (g) When above checks are made for two speed servos, voltage at 32X test point should go through one cycle for every 5.6° or 180° rotation of 32 speed shaft.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo Systems (Cont)			It requires 16 turns of the 32X shaft to cause the one speed error voltage to go through one cycle. (h) For servos whose input is supplied by test panel installed DRC's, command input signals cannot be varied by use of test panel controls. Check is accomplished by setting appropriate selector switches to a given position and rotating output member of servo by hand. **CAUTION** Do not touch optical assemblies with bare hands.
	d. When two speed servo test panel director is rotated smoothly and continuously in one direction, output	(1) Resolvers controlling servo are not properly adjusted.	(a) Check alignment of sextant servos.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
2. Sextant Servo Systems (Cont)	member appears to track continuously for a time then jumps abruptly in a definite direction by a noticeable amount, and following this jump appears to track satisfactorily again.		
3. Sextant Landmark Scene Generation	a. Carousel fails to rotate on command signal from computers. NOTE Table 3-2 contains the required data on long cable numbers, connectors, and terminal boards. Table 3-3 contains information on terminal board locations in the sextant.	(1) Improper signal transmission from computers to electronics cabinet.	(a) Refer to applicable computer manual for instructions to check out computer operation.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
3. Sextant Landmark Scene Generation (Cont)		(2) Incorrect signal transmission from electronics cabinet carousel electronics.	(a) Check out carousel electronics in unit 9.
		(3) Broken lead in long cable between electronics cabinet and sextant.	(a) Refer to table 3-2. Make continuity test between applicable cabinet connector. Replace broken leads discovered, or repair connection.
		(4) Loose or open connection on sextant terminal board. Refer to Table 3-3 for T.B. designation, location, and applicable connection points.	(a) Inspect, tighten, or reconnect T.B. connections as required. Access to carousel terminal board, 12TB10, is gained by removal of carousel front side cover panel, figure 4-8.
		(5) Defective carousel servo system; motor-generator or resolver or both.	(a) Refer to a-c servo loop check out in order to determine, if possible, which servo component is defective. Refer to Section IV of this manual for replacement instructions.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
3. Sextant Landmark Scene Generation (Cont)		(6) Landmark slide not fully retracted into slide magazine, or, if fully retracted, failure of switch in slide actuation subassembly.	(a) See remedies for slide actuation malfunctions.
		(7) Mechanical defect in carousel gearing or bearings.	(a) Replace carousel with spare assembly. See Section IV for replacement instructions.
	b. Carousel rotates on command, but too slowly.	(1) Incorrect power transmission to motor-generator.	(a) Check power supplies, and carousel electronics cabinet.
		(2) Same as 3a (7) for rotation failure.	(a) Replace carousel assembly.
	c. Carousel rotates, but fails to index for commanded slide.	(1) Incorrect signal transmission from computers.	(a) Checkout computer. See appropriate computer manual.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
3. Sextant Landmark Scene Generation (Cont)		(2) Incorrect signal transmission from electronics cabinet.	(a) Checkout carousel electronics in cabinet.
		(3) Defective resolver in carousel servo system.	(a) Replace resolver. See Section IV for instructions.
	d. Landmark slide is not retracted in order to permit carousel rotation.	(1) Incorrect signal transmission from electronics cabinet to slide actuator electronics assembly mounted on landmark side of combined light source housing.	(a) Checkout slide selection electronics in cabinet.
		(2) Defective electronics assembly on landmark light source housing.	(a) Replace electronics assembly.
		(3) Broken lead or open connection in short cable harness between connector 12J5 and slide actuator electronics assembly.	(a) Perform continuity test and replace broken lead or reconnect open connection, as required.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
3. Sextant Landmark Scene Generation (Cont)		(4) Loose or open connection on terminal board 12TB11.	(a) Remove carousel front side cover panel, figure 1-11; tighten or reconnect loose or open connection.
		(5) Inoperative switch, or displaced switch actuation cam or slide actuating mechanism subassembly.	(a) Remove carousel left side cover panel, figure 1-11; and replace switch, or reposition switch actuating cam.
		(6) Injection rod clamp loosened.	(a) Reposition and tighten clamp.
		(7) Mechanically defective slide actuating mechanism subassembly.	(a) Replace slide actuating mechanism with spare subassembly.
		(8) Mechanically defective slide gate assembly.	(a) Replace slide gate assembly with spare assembly.
	e. Landmark optical path insufficiently illuminated, or not illuminated.	(1) Low voltage to landmark light source lamp.	(a) Check voltage at electronics cabinet.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
3. Sextant Landmark Scene Generation (Cont)		(2) Landmark light source lamp burned out.	(a) Replace lamp. See Section VII.
		(3) Open or loose connection on terminal boards 12TB12 or 12TB14.	(a) Tighten or repair connections.
4. Sextant Landmark and Starfield Rhomb Scanners	a. Alpha rhomb fails to scan the arc tangential to the Y axis of the landmark test pattern.	(1) Carousel rotation failure.	(a) Refer to landmark scene generation 3, a, b, c, and d for carousel rotation failure.
		(2) Beta rhomb improperly zeroed.	(a) Check beta rhomb positioning and adjust for correct zeroing.
		(3) Variable magnification not set for unit (1:1) magnification.	(a) Correct variable magnification setting.
		(4) Loose or defective 1X or 32X resolver.	(a) Check resolvers. If loose, rezero and tighten; if defective, replace resolvers.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
4. Sextant Landmark and Starfield Rhomb Scanners (Cont)		(5) Defective drive motor.	(a) Replace drive motor.
		(6) Dirt in assembly gearing.	(a) Clean the assembly.
		(7) Loose or displaced rhomboid.	(a) Tighten rhomboid, if loose, or reposition as required. Refer to Section VI for alignment procedures.
		(8) Mechanical failure; defective gearing and/or bearings.	(a) Replace rhomb scanner assembly.
		(9) Displaced fixed optical element.	(a) Re-position and align displaced element.
	b. Beta rhomb fails to scan the arc tangential to the test pattern X axis.	(1) Refer to 4a. Alpha rhomb failure.	(a) Refer to 4a alpha rhomb failure.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
4. Sextant Landmark and Star-field Rhomb Scanners (Cont)	c. Scanning is too fast, too slow, jerky or otherwise non-simulatory.	(1) Improper signal transmission from computers to cabinet, or from cabinet to sextant.	(a) Checkout signal transmission.
		(2) Jerky or uneven scanning is probably caused by dirt in the gearing or bearings.	(a) Remove sextant cover and clean dirt from the assembly insofar as possible with assembly in place.
			(b) Continued faulty operation necessitates removal of the assembly for thorough cleaning.
	d. Alpha or beta scanner fails to return from either limit of travel, following actuation of limit switch.	(1) Defective limit switch. Electrical defect in circuitry.	(a) Replace limit switch. Checkout circuitry.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
5. Sextant Starfield Scene Generation (Cont)	c. Starfield optical path improperly illuminated or not illuminated.	(1) Insufficient voltage or starfield lamp burned out.	(a) Check voltage input or, if necessary, replace starfield lamp. See Section VII.
	d. Star group properly presented, but no navigational star visible.	(1) Burned out navigational star lamp.	(a) Replace lamp. See Section VII.
6. Sextant Landmark Variable Magnification	a. Variable magnification assembly fails to operate on command.	(1) Carousel rotation failure.	(a) Refer to landmark scene generation 3 a, b, c, and d for carousel rotation failure.
		(2) Defective servo system.	(a) Replace motor-generator and/or resolver. See Section V.
		(3) Mechanical defect in variable magnification gearing or bearings.	(a) Replace variable magnification assembly. See Section IV.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
5. Sextant Starfield Scene Generation	a. Starfield generator fails to present commanded star group in the starfield optical path.	(1) Carousel rotation failure.	(a) Refer to landmark scene generation 3 a, b, c, and d for carousel rotation.
		(2) Defective starfield selection servo system.	(a) Replace defective drive motor assembly.
		(3) Dirt in assembly, or loose differential clamp.	(a) Clean assembly. (b) Tighten clamp.
		(4) Mechanical defect in gearing or bearings.	(a) Replace starfield generator assembly.
	b. Star group fails to rotate on command.	(1) Failure of starfield rotation servo system or mechanical defect in starfield generator.	(a) Refer to 5a starfield selection.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
6. Sextant Landmark Variable Magnification (Cont)	b. Variable magnification operates on command, but operation is jerky or too slow.	(1) Presence of dirt on lead screw or in ball bushings.	(a) Remove sextant cover and left side cover panel.
			(b) Clean assembly insofar as possible.
			(c) Continued malfunction necessitates replacement of the assembly.
		(2) Len(es) loose in mounting(s).	(a) Tighten mountings as required.
	c. Limit switches fail to operate to either end of travel.	(1) Disconnected or defective switches.	(a) Check and repair T.B. connections, or replace switches.
	d. Rotating polaroid fails to operate on command.	(1) Carousel rotation failure.	(a) Refer to landmark scene generation 3 a, b, c, and d for carousel rotation failure.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
6. Sextant Landmark Variable Magnification (Cont)		(2) Defective servo system.	(a) Replace drive motor assembly.
		(3) Mechanical defect in gearing or bearings.	(a) Replace rotating polaroid filter assembly.
	e. Rotating polaroid rotates but rotation is jerky.	(1) Insufficient power transmission or dirt in assembly gearing or bearings.	(a) Check power transmission from cabinet. (b) Remove sextant cover and clean assembly insofar as possible. (c) If malfunction persists, replace the assembly.
7. Sextant Rotating Reticle Assembly	a. Insufficient or complete lack of reticle illumination.	(1) Insufficient power transmission from cabinet unit 9.	(a) Check power transmission including position of rheostat on power panel in electronics cabinet.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
7. Sextant Rotating Reticle Assembly (Cont)		(2) Broken long cable lead(s) or open terminal board connection.	(a) Refer to landmark scene generation 3 c and d for carousel rotation failure.
		(3) Burned out edge light(s).	(a) Replace edge lights.
	b. Rotating reticle fails to rotate on command.	(1) Carousel rotation failure.	(a) Refer to 3a through 3d for carousel rotation failure.
		(2) Defective rotating electrical component or bearings.	(a) Replace rotating reticle.
	c. Rotating reticle fails to position properly.	(1) Faulty signal transmission, either from computers or from electronics cabinet.	(a) Check signal transmission.
	d. Excessive reticle run-out.	(1) Displaced reticle; worn bearings.	(a) Replace rotating reticle.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
7. Sextant Rotating Reticle Assembly (Cont)	e. Rotating prism fails to rotate on command.	(1) Carousel rotation failure.	(a) Refer to 3a through 3d for carousel rotation failure.
		(2) Defective rotating electrical component or bearings.	(a) Replace rotating prism assembly.
	f. Rotating prism fails to position properly.	(1) Faulty signal transmission from computers or from electronics cabinet.	(a) Check signal transmission.
		(2) Defective rotating electrical component.	(a) Replace rotating prism assembly.
	g. Excessive rotating prism run-out.	(1) Loose or displaced prism.	(a) Reposition and align prism.
8. Sextant Sunshafting Effect	a. Sunshafting lamp fails to illuminate on command.	(1) Broken long lead(s) or open terminal board connection.	(a) Refer to 3c and 3d for carousel rotation failure.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
8. Sextant Sunshafting Effect (Cont)		(2) Burned out sunshafting lamp.	(a) Replace sunshafting lamp. See Section VII.
9. Out-the-Window Optical System	a. All images poor regardless of input being projected.	(1) Deposits of grease, hair, dust, or oil on lens.	(a) Check and clean window beamsplitter No. 1, corrector lens No. 1, beamsplitter No. 2, and corrector lens No. 2.
	b. Television input image bears clear image of deposit.	(1) Deposits of grease, hair, dust, or oil on lens.	(a) Check and clean the face plate of the TV input and the screen.
	c. MEP input images bear clear image of deposit.	(1) Deposits of grease, hair, dust, or oil on lens.	(a) Check the MEP input and screen.
			(b) Clean the lens.
	d. Television input image appear hazy or foggy.	(1) Deposits of grease, hair, dust, or oil on lens.	(a) Check the elements of the TV input projection system.
			(b) Clean the lens.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
9. Out-the-Window Optical System (Cont)	e. MEP input appears hazy or foggy.	(1) Deposits of grease, hair, dust, or oil on lens.	(a) Check the elements of the MEP input optical system.
			(b) Clean the lens.
	f. Blinking star effect	(1) Deposits of grease, hair, dust, or oil on lens.	(a) Check and clean the optical elements of C/S earth, moon occulation system and LEM occultation system.
	g. Loss of star contrast. Image of "feed in length" of tape of occultation disc appears as curved silhouette against C/S.	(1) Reflective dust and grease deposits.	(a) Check the C/S.
			(b) Check the feed in length of the tape.
			(c) Clean the lens or sphere.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
9. Out the Window Optical System (Cont)	h. Occultation disc shine through phenomena.	(1) Dust collection upon elements of the tape length in sufficient quantity to preclude each consecutive tape layer from lying in complete contact with its adjacent layer during wind up. Failure of the tape drives to apply adequate tension to the tape.	(a) Check the elements of the tape length. (b) Check the tape drives. (c) Clean the element.
	i. Image impairment noticed through the command module window.	(1) Loss of pneumatic pressure in mirror or beamsplitter pneumatic mounting.	(a) Individually check each tube pressure with the permanently installed gauge on each window display using the following typical procedure. 1. Check that all individual pneumatic tube valves are open. 2. Open normally closed valve 5.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
9. Out the Window Optical System (Cont)			3. Close all other valves. 4. Insure that the gauge reads 0. If gauge does not read 0, bleed off air at valve "9" until a 0 reading is obtained. 5. Open valve "8" and record pressure reading. 6. Close valve "8" and bleed off pressure from manifold assembly at valve "9". 7. Open valve "7" and record pressure reading. Subsequently close this valve and bleed off pressure from manifold assembly at valve "9".

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
9. Out the Window Optical System (Cont)			8. Repeat the above procedure for valves "6" through "1" to obtain data indicating the pressure of each pneumatic tube. 9. If any tube yields a pressure well below the mean pneumatic pressure of all tubes, conduct leak detection procedures as specified in Section V. 10. Repair leak in tube or reinflate tube as necessary to 10 psig.
10. C/S Pitch Axis	a. Failure to synchronize (presence of a limit cycle).	(1) Open tachometer feedback path due to: open diode (A1CR1); open resistor (A1R12); faulty tachometer gain adjust (R4).	(a) Check components for continuity. Replace defective comonent.
		(2) No tachometer feedback.	(a) Check tachometer signal at TB2-5 and TB2-6. Replace defective tachometer.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
10. C/S Pitch Axis (Cont)	b. Inability to follow high input rates. (Input rates must be within limits specified for servo.)	(1) Tachometer gain set too high, or pitch gain set too low (due to component replacement or similar cause).	(a) Decrease tachometer adjustment and/or increase pitch gain adjustment until servo follows within specified limits.
	c. Servo oscillates.	(1) Gain set too high (due to component replacement or similar cause).	(a) Decrease gain adjustment potentiometer R3.
		(2) Malfunction in lead-lag network caused by defective resistor A1R7 or capacitor A1C5.	(a) Check components, replace if defective.
	d. Servo does not follow commands. No torque on axis.	(1) Open error path signal.	(a) Check signal leads for continuity.
			(b) Check plug-in modules.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
10. C/S Pitch Axis (Cont)	e. Servo continually drives in one direction.	(1) Defective module (one side shorted signal).	(a) Position the 115 volt, 400 cps power switch located on "celestial sphere A1" electronics chassis to "OFF". (This deenergizes preamp and demodulator module AR2.) (b) If servo still rotates, short inputs to the d-c preamplifier AR3 and monitor its output. (c) If output is other than a null, the preamplifier is defective and should be replaced. (d) If output is a null the trouble is in the 100-watt d-c amplifier AR4. (e) Remove d-c preamplifier from chassis and short inputs to 100-watt power amplifier.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
10. C/S Pitch Axis (Cont)			(f) If output is other than a null, (axis still rotates) check output transistors Q1 and Q2 and power amplifier. Replace if necessary.
	f. Output transistors overheating. (Too hot to be touched.)	(1) 400 cycle series trap opened.	(a) Check A1C7 and A1L2 series combination. Replace if defective.
11. C/S Yaw Axis	a. Failure to synchronize (presence of a limit cycle).	(1) Open tachometer feedback path due to: open diode (A1CR2); open resistor (A1R19), faulty tachometer gain adjust (R6).	(a) Check components for continuity.
			(b) Replace defective component.
		(2) No tachometer feedback.	(a) Check tachometer signal at TB3-5 and TB3-6.
			(b) Replace defective tachometer.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
11. C/S Yaw Axis (Cont)	b. Inability to follow high input rates. (Input rates must be within limits specified for servo.)	(1) Tachometer gain set too high, or pitch gain set too low (due to component replacement or similar cause).	(a) Decrease tachometer adjustment and/or increase pitch gain adjustment until servo follows within specified limits.
	c. Servo oscillates.	(1) Gain set too high (due to component replacement or similar cause).	(a) Decrease gain adjustment potentiometer R3.
		(2) Malfunction in lead-lag network caused by defective resistor A1R14 or capacitor A1C9.	(a) Check components, replace if defective.
	d. Servo does not follow commands. No torque on axis.	(1) Open error path signal.	(a) Check signal leads for continuity.
			(b) Check plug-in modules.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
11. C/S Yaw Axis (Cont)	e. Servo continually drives in one direction.	(1) Defective module (one side shorted signal).	(a) Position the 115 volt, 400 cps power switch located on "celestial sphere A1" electronics chassis to "OFF". (This deenergizes preamplifier and demodulator module AR5). (b) If servo still rotates, short inputs to the d-c preamplifier AR6 and monitor its output. (c) If output is other than a null, the preamplifier is defective and should be replaced. (d) If output is a null, the trouble is in the 100-watt d-c power amplifier AR7. (e) Remove d-c preamplifier from chassis and short inputs to 100-watt power amplifier.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
11. C/S Yaw Axis (Cont)			(f) If output is other than a null, (axis still rotates) check output transistors Q3 and Q4 and power amplifier. Replace if necessary.
	f. Output transistors overheating. (Too hot to be touched.)	(1) 400 cycle series trap opened.	(a) Check A1C11 and A1L1 series combination. Replace if defective.
12. C/S Roll Axis	a. Failure to synchronize.	(1) Open resistor A1R3 or faulty tachometer. Adjust potentiometer R2.	(a) Check components for continuity.
			(b) Replace defective component.
		(2) Trouble in the synchronizing circuit which activates relay A1K1 and applies tachometer feedback to the servo lag.	(a) Check relay contacts A1K1 poles 1 and 7 for closure when relay is operated.
			(b) Check remaining components in the synchronizing circuit.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
12. C/S Roll Axis (Cont)	b. Inability to follow high input rates. (Input rates must be within limits specified for the servo.)	(1) Malfunction in synchronizing circuit.	(a) Reset synchronizing gain circuit by raising value of resistor A1R16 for proper relay pull-in.
	c. Servo oscillates.	(1) Gain set too high (due to component replacement or similar causes).	(a) Decrease gain adjustment potentiometer R1.
		(2) Improper setting of gain selector or roll axis power amplifier A2.	(a) Set gain selector to the "100" position.
	d. Servo does not follow commands. No torque on axis.	(1) Open error path signal.	(a) Check signal leads for continuity.
			(b) Check plug-in modules.
	e. Servo continually drives in one direction.	(1) Defective module (one side shorted signal).	(a) Position the 115 volt, 400 cps power switch located on "celestial sphere electronics chassis A1" to "OFF".

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
12. C/S Roll Axis (Cont)			(This deenergizes the preamplifier and demodulator module AR1). (b) If servo still rotates, short input to the 500-watt d-c power amplifier A2 and check output by noting reading of front panel meter. Meter should read null on all scales and servo should stop. (c) If servo still rotates and output is other than null, refer to unit 13.
13. MEP Optical System	a. Solar presentation has operational problem in direction parallel to the orbital flight direction.	(1) Component defect in Solar Image yaw axis.	(a) Refer to DC Servo trouble analysis, number 14.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
13. MEP Optical System (Cont)	b. Solar presentation has operational problem in direction perpendicular to the orbital flight direction.	(1) Component defect in Solar Image pitch axis.	(a) Refer to DC Servo trouble analysis, number 14.
	c. Solar presentation is not in focus.	(1) Component defect in Solar Image focus equipment.	(a) Refer to DC Servo trouble analysis, number 14.
	d. Solar presentation appearance is not controllable.	(1) Component defect in Solar Image blanking equipment.	(a) Refer to Solenoid Drive trouble analysis, number 18.
	e. Solar presentation illumination level is not controllable.	(1) Component defect in Solar Image iris equipment.	(a) Refer to DC Drives trouble analysis, number 17.
	f. Turret I does not index properly.	(1) Defect in Turret I drive.	(a) Refer to DC Servo trouble analysis, number 14.
	g. Turret II does not index properly.	(1) Defect in Turret II drive.	(a) Refer to DC Servo trouble analysis, number 14.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
13. MEP Optical System (Cont)	h. Earth orbital view presentation has an operational problem along the orbital path.	(1) Component defect in the Near-Earth Orbital View.	(a) Refer to AC Servo trouble analysis, number 15.
	i. Lunar orbital view presentation has an operational problem along the orbital path.	(1) Component defect in the Mid-Moon Orbital View.	(a) Refer to AC Servo trouble analysis, number 15.
	j. Earth slide presentation has an operational problem along the orbital path.	(1) Component defect in the Trans-Earth View.	(a) Refer to AC Servo trouble analysis, number 15.
	k. Lunar slide presentation has an operational problem along the orbital path.	(1) Component defect in the Trans-Lunal View.	(a) Refer to AC Servo trouble analysis, number 15.
	l. Earth or Lunar slide presentation has an operational problem perpendicular to the orbital path.	(1) Component defect in the Off-Course I.	(a) Refer to DC Servo trouble analysis, number 14.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
13. MEP Optical System (Cont)	m. Earth or Lunar orbital view presentation has an operational problem perpendicular to the orbital path.	(1) Component defect in the Off-Course II.	(a) Refer to DC Servo trouble analysis, number 14.
	n. Illuminated spot size of the Earth or Lunar slide presentation has an operational problem.	(1) Component defect in the Earth/Moon Illumination I.	(a) Refer to DC Servo trouble analysis, number 14.
	o. Illuminated spot size of the Earth or Lunar orbital view presentation has an operational problem.	(1) Component defect in the Earth/Moon Illumination II.	(a) Refer to DC Servo trouble analysis, number 14.
	p. Altitude of the Earth or Lunar slide presentation has an operational problem.	(1) Component defect in the Vertical Range I.	(a) Refer to DC Servo trouble analysis, number 14.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
13. MEP Optical System (Cont)	q. Altitude of the Earth or Lunar orbital view has an operational problem.	(1) Component defect in the Vertical Range II.	(a) Refer to DC Servo trouble analysis, number 14.
	r. Slow darkening of the Earth or Lunar slide presentation has an operational problem.	(1) Component defect in the Iris.	(a) Refer to DC Servo trouble analysis, number 14.
	s. Day-Night Terminator has an operational problem.	(1) Component defect in the Terminator.	(a) Refer to DC Servo trouble analysis, number 14.
	t. Inclination of the Day-Night Terminator has an operational problem.	(1) Component defect in the Terminator Rotator.	(a) Refer to DC Servo trouble analysis, number 14.
	u. Switching between the Earth or Lunar slide presentation and the Earth or Lunar orbital view presentation has an operational problem.	(1) Component defect in the Quick Dissolve I or Quick Dissolve II.	(a) Refer to DC Drive trouble analysis, number 17.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
13. MEP Optical System (Cont)	v. Simulation curvature of the Earth or Lunar slide presentation has an operational problem.	(1) Component defect in the Distortion Lens I.	(a) Refer to DC Drive trouble analysis, number 17.
	w. Simulation of curvature of the Earth or Lunar orbital view presentation has an operational problem.	(1) Component defect in the Distortion Lens II.	(a) Refer to DC Drive trouble analysis, number 17.
	x. Earth or Lunar presentation appearance is not controllable.	(1) Component defect in the Earth Blanking.	(a) Refer to Solenoid Drive trouble analysis, number 18.
	y. Cloud cover or lunar terrain presentation has an operational problem along the orbital path.	(1) Component defect in the Trans-Boundary View.	(a) Refer to AC Servo trouble analysis, number 15.
	z. Illuminated spot size of the cloud cover or lunar terrain presentation has an operational problem.	(1) Component defect in the Trans-Boundary Illumination.	(a) Refer to DC Servo trouble analysis, number 14.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
13. MEP Optical System (Cont)	aa. Altitude of the cloud cover or lunar terrain presentation has an operational problem.	(1) Component defect in the Trans-Boundary Vertical Range.	(a) Refer to DC Servo trouble analysis, number 14.
	ab. Diameter of the cloud cover or lunar terrain presentation has an operational problem.	(1) Component defect in the Trans-Boundary Limb Variation.	(a) Refer to DC Servo trouble analysis, number 14.
	ac. Orientation of the cloud cover or lunar terrain has an operational problem.	(1) Component defect in the Trans-Boundary Cassette Rotator.	(a) Refer to DC Servo trouble analysis, number 14.
	ad. Superimposition of the cloud cover or lunar terrain over the Earth or Lunar view has an operational problem.	(1) Component defect in the Extended Off-Course.	(a) Refer to DC Servo trouble analysis, number 14.
	ae. Simulation of sunrise or sunset has an operational problem.	(1) Component defect in the Horizon Mask.	(a) Refer to DC Drive trouble analysis, number 17.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
13. MEP Optical System (Cont)	af. Cloud cover or lunar terrain presentation appearance is not controllable.	(1) Component defect in the Trans-Boundary Blanking.	(a) Refer to Solenoid Drive trouble analysis, number 18.
	ag. Attitude of the capsule has an operational problem along the orbital path.	(1) Component defect in the Attitude Pitch Axis.	(a) Refer to Dual Speed AC Servo trouble analysis, number 16.
	ah. Attitude of the capsule has an operational problem perpendicular to the orbital path.	(1) Component defect in the Attitude Yaw Axis.	(a) Refer to Dual Speed AC Servo trouble analysis, number 16.
	ai. Rotation of the orbital view has an operational problem.	(1) Component defect in the Attitude Roll Axis.	(a) Refer to Dual Speed AC Servo trouble analysis, number 16.
14. MEP DC Servos	a. DC Servo runs into either limit, 28 volts dc indicator light out.	(1) Flipover of wires due to replacement of components.	(a) In the Motor Control Phase, check the wiring from the output of the power amplifier (AR2, pins E and F) to the servo motor terminals 2 and 4.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			The wire on XAR2-E should be white. The wire on XAR2-F should be black. (b) In the Motor Reference Phase: 1. Check the wiring from the output of the phase shifting capacitors (C1 and C2) to the servo motor terminals 1 and 3. The wire from the junction of C1 and C2 should be white. 2. Check the wiring of the input 115 volts 400 cps to the electronic chassis. On the backboard, the high side should be white and on TB--12, and the low side should be black and on TB--11.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			(c) Across the feedback potentiometer, check for ±10 volts dc at the correct terminals on the potentiometer.
			(d) At the 26 volt 400 cps reference to the modulator, check the wiring of the modulator socket. Pin 1 should be in phase with the 115 volts 400 cps high side. Pin 2 should be at ground potential.
		(2) Input signal is larger than the maximum allowable signal data drawings (Section VIII).	(a) In the automatic mode, check computer input signal at the appropriate test point on the test panel. If the signal is excessive, the computer is at fault.
			(b) In the manual mode, check for manual input signal at the appropriate test point

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			on the test panel. If the signal is excessive, adjust the manual control potentiometer on the test panel to within the maximum allowable limits.
		(3) Open position feedback path.	(a) For faulty potentiometer or gearing: 1. Check for potentiometer continuity. If open, replace. 2. Check the potentiometer for gearing slippage. If the gear has slipped, realign the potentiometer and tighten the clamp.
			(b) Check for continuity from the output lead on the feedback potentiometer to pin 1 on the network assembly (A1).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			(c) For faulty summing network (A1):
			1. Check feedback summing resistor A1R5 for correct resistance.
			2. Check for continuity between A1R5 and pins 1 and 2 of the network assembly.
		(4) Loss of ±10 volt dc reference power to feedback potentiometer.	(a) Check for ±10 volts dc across the potentiometer. If either voltage is missing or incorrect:
			1. Check the wiring according to the wiring diagrams in Section VIII.
			2. Check the ±10 volt dc power supplies (A21 and A22) for the correct output voltage.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)	b. DC Servo does not run in manual.	(1) Servo in limit.	(a) Refer to 14.a.
		(2) Open or grounded input signal path.	(a) In the manual mode, check for the presence of the input signal at the network assembly (A1) pin 3 as the test panel potentiometer is varied. 1. When a signal is present at XA1-3: a. Check for continuity between the sum ratio adjust potentiometer (A1R3) and XA1-3 and A1R6. b. Check for continuity between A1R6 and XA1-2. c. Check for correct resistance of A1R3 and A1R6.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			NOTE Do not change the setting of A1R3. 2. When a signal is not present at XA1-3: a. Check the test points on the test panel for presence of the input signal. b. Check the wiring from the test panel to the network assembly XA1-3. c. Check for continuity between XA1-3 and ground. Short circuit should not be present.
		(3) Open or grounded error signal path.	(a) Grounded - Check list below for continuity to ground. Short circuit should not be present:

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			1. Remove the modulator and check XA1-2, XA2-4, pin 7, and pin 5 on the modulator socket. 2. Remove the preamplifier (AR1) and check XA1-5, XA1-9, XA1-F, and XAR1-B. 3. Remove the power amplifier (AR2) and check XA1-8, XAR2-B, XAR2-E, and XAR2-F. (b) Open - Check the following points for continuity: 1. Input feedback summing junction to the input of the modulator, XA1-2 to pin 7 on the modulator socket. 2. Output of the modulator to the tachometer summing junction, pin 5 on the modulator socket to XA1-4.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			3. Internal to the network assembly (A1), A1R4-R to XA1-4, A1R4-G to A1R7, and A1R7 to XA1-5. 4. Check A1R4 and A1R7 for correct resistance. 5. Output of the tachometer summing junction to the input of the preamplifier, XA1-5 to XAR1-F. Check gain reducing resistor R5 for correct resistance, if assembly is equipped with gain reducing resistor. 6. Output of the preamplifier to the input of the power gain control, XAR1-B to XA1-9.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			7. Check the power gain potentiometer (A1R1) for correct resistance. Check A1R1-R to XA1-8.
			8. Output of the power gain control to the input of the power amplifier XA1-8 to XAR2-B.
			9. Output of power amplifier to control phase of motor XAR2-E to white wire on motor terminals 2 or 4, XAR2-F to black wire on motor terminals 2 or 4.
		(4) Loss of reference power.	(a) For reference power to the modulator:
			1. Check for presence of 26 volt 400 cps at pin 1 of the modulator socket with respect to pin 2 (ground).
			2. If the voltage is not present, check the wiring and the presence of 26 volts 400 cps coming into the electronics chassis

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			(b) For power for the reference phase of the servomotor: 1. Check for presence of 115 volts 400 cps at terminals 1 and 3 on the servomotor. The 400 cps voltage should be greater than 75 volts rms. 2. Check for a nominal 90 degree phase shift between the input and output of the phase-shifting capacitors (C1 and C2). 3. Check the phase-shifting capacitors (C1 and C2) for an open or short. 4. Check the input to the phase-shifting capacitors (C1 and C2). The voltage should be 115 volts 400 cps and in phase with the prime power.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			5. If the voltage is not present, check the wiring and the presence of 115 volt 400 cps coming into the electronics chassis. (c) For 28 volts dc: 1. Blown fuse - Check front of electronics rack for any illuminated fuse holders and replace with fuse of appropriate type and value. 2. Check for 28 volts dc at the power amplifier XAR2-C with respect to XAR2-A and XAR2-D (ground). 3. Check for 28 volts dc at the preamplifier XAR1-A with respect to XAR1-C (ground).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			4. Check for 28 volts dc at the modulator socket pin 3 with respect to pins 2, 4, and 8 (ground). 5. If a filter is utilized, check the 470 ohm resistor for continuity and the 22 microfarad capacitor for a short. The output of the filter is nominally 24 volts dc. 6. Check for 28 volts dc at the servomotor centertap terminals 5 and 6 on the servomotor. 7. Check for 28 volts dc on the limit relay XK1-6.
		(5) Gain too low.	(a) Increase the power gain by turning potentiometer A1R1 clockwise.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)		(6) Faulty electrical component.	(a) Apply the maximum input signal in the manual mode and check for the presence of the correct signal at the points listed below. If no signal exists at the output of a stage, replace the major component in that stage: 1. Modulator - Input XA1-2, low level dc signal with noise. Output XA1-4, 400 cps sine wave signal proportional to the input. 2. Preamplifier - Input XA1-5, 400 cps sine wave signal. Output XA1-9, 400 cps sine or clipped sine wave.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			3. Power amplifier - Input XA1-8, 400 cps sine or clipped sine wave. Output XA2-E and -F, 400 cps sine wave with harmonic distortion. 4. Check the motor control phase tuning capacitor (C3) for a short, with the power amplifier and output lead to the motor control phase disconnected. 5. Limit relay (K1) - Check the relay for operation and continuity between contacts.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)		(7) Faulty mechanical component.	(a) Remove the motor gearhead from the assembly and apply the maximum manual mode input signal at the test panel. Check the motor for operation: CAUTION Normal motor operating temperature is 125 degrees centigrade. 1. Gearing and load - With the motor removed, manually rotate the input shaft. No binding should occur, and continuity should exist throughout the gear train. 2. Clutch - If a clutch is utilized, repeat the previous step (1.) and check in the "Man. IX" and "Man. Incr. Rt" modes. 3. If binding exists, remove the last gear pass to the load and recheck gearing and load motion for binding.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			a. Load binding - Remove and replace servo-motor. b. Gear binding - Check gears and/or speed reducer for wear of damage, and replace faulty components,
	c. DC Servo is unstable.	(1) Gain too high.	(a) Reduce power gain by turning the power gain control (A1R1) counterclockwise. Then, in the decreased rate mode, check for the proper value of gain reducing resistor, if this resistor is utilized.
		(2) Tachometer signal reversed - Tachometer signal should be 180 degrees out of phase with the output of the modulator.	(a) Check the tachometer excitation on the servomotor: 1. Terminal 7 should be 115 volts 400 cps high, and the wire on terminal 7 should be white.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			2. Terminal 10 should be 115 volts 400 cps low (ground), and the wire on terminal 10 should be black.
			(b) Check the tachometer output on the servomotor. Also, check for the correct wiring to terminals 8 and 9 on the servomotor.
		(3) Loss of tachometer signal.	(a) With the servo running, check for the presence of a 400 cps tachometer signal at terminals 8 and 9 on the servomotor.
			1. Check for continuity of the series tach resistor (R1), if this resistor is utilized.
			2. Check for the presence of the tachometer signal at XA1-6.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			3. Check for continuity of the tach gain resistor (A1R2). 4. Check for continuity between A1R2-R and A1R8. 5. Check tachometer summing resistor A1R8 for continuity. 6. Check for continuity between A1R8 and XA1-5.
		(4) Servo operating in an improper manner.	(a) Vertical Range I and II should be operated in the "IX" mode except for slewing between +10 volts dc and -10 volts dc. Also, the terminator should be operated in the "IX" mode except for slewing between -10 volts dc and +7.445 volts dc.
	d. DC servo has a large velocity error.	(1) Gain too low.	(a) Increase the power gain by turning the potentiometer (A1R1) clockwise, and while in the increased rate

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			mode, check gain reducing resistor R5 for proper resistance.
			(b) Malfunction may be faulty component, therefore sequentially replace the power amplifier, modulator, and preamplifier. If the large error is decreased, then the component replaced is faulty.
		(2) Tachometer gain too high.	(a) Reduce the tach gain by turning potentiometer A1R2 counterclockwise.
			(b) Check the series tachometer resistor (R1) for the correct resistance.
			(c) Check the tachometer summing resistor (A1R8) for the correct resistance.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)		(3) Mechanical problems.	(a) For binding or excessive friction in the gear train or load, refer to 13.b. (7) (a) 3.
	e. DC servo does not position correctly.	(1) Summing ratio adjust potentiometer A1R3 not set properly, due to replacement.	(a) Check the static positioning by setting the manual servo control to a known value and reading the servo output. If the static error is excessive, readjust the sum ratio adjust (A1R3) until the linearity is within the specifications.
		(2) Summing resistors have the wrong value, due to replacement.	(a) Check resistors A1R5 and A1R6 for the correct resistance.
		(3) Feedback potentiometer is not in the correct position.	(a) Misalignment may be due to replacement of this potentiometer, therefore, realign.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
14. MEP DC Servos (Cont)			(b) If the potentiometer gear is slipping, tighten the clamp on the gear and realign the potentiometer, according to the alignment procedures as stated in Section IV (Removal and Replacement), or Section VI (Calibration and Adjustment).
15. MEP AC Servos	a. AC servo does not run in auto or manual.	(1) Open or grounded input of resolver feedback signal path.	(a) In manual, check the test panel test points for signal as the resolver is rotated. (Insure that test panel 26 volts 400 cps is on).
			(b) Check network assembly XA1-4 for varying ac error signal, as resolver is rotated:
			1. Error signal present at XA1-4, grounded - Check the following points for continuity to ground. Short circuit should not be present:

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			a. Remove the preamplifier (AR1) and check XA1-5, XA1-9, XAR1-F, and XAR1-B. b. Remove the power amplifier (AR2) and check XA1-8, XAR2-B, XAR2-E, and XAR2-F. 2. Error signal present at XA1-4, open - Check the following points for continuity: a. Internal to the network assembly (A1) A1R4-R to XA1-4, A1R4G to A1R7, and A1R7 to XA1-5. b. Check A1R4 and A1R7 for correct resistance.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			c. Output of the tachometer summing junction to the input of the preamplifier XA1-5 to XAR1-F. If gain reducing resistor (R5) is used in this equipment, check for correct resistance. d. Output of the preamplifier to input of the power gain control XAR1-B to XA1-9. e. Check power gain potentiometer (A1R1) for correct resistance. Check A1R1-R to XA1-8. f. Output of the power gain control to the input of the power amplifier XA1-8 to XAR2-B.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			g. Output of power amplifier to cassette connector socket (Near Earth Orbital View, Trans-(Earth) View, Mid Moon Orbital View, pins L to N) (Trans-Boundary View, pins N to P), with cassette removed. 3. If error signal is not present, first insure that cassette is properly mated with connector, then: a. Check for error signal at relay XK1-1. b. Check for short from XK1-1 to ground. c. Check for error signal at backboard. d. Check for S1 to S3 and S2 to S4 input signals at turret terminals.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			e. Remove cassette and check for S1-S3 and S2-S4 signals at connector Near Earth Orbital View, Trans-(Earth) View, (Mid Moon Orbital View, Trans-Lunar View, pins T to V and pins U to Z) (Trans-Boundary View, pins U to V and pins W to X). f. Continuity check R1 lead from connector to turret terminals (Near Earth Orbital View, Trans-(Earth) View, Mid Moon Orbital View, Trans-Lunar View, pin C, and Trans-Boundary View pin A).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			g. Continuity check R1, S1-S3, and S2-S4 leads from cassette connector to appropriate cassette terminals.
		(2) Loss of 115 volts 400 cps reference power for the reference phase of the servomotor.	(a) Check for presence of voltage at terminals 1 and 3 on the servomotor. The 400 cps voltage should be greater than 75 volts rms. (b) In testing phase shifting capacitors (C1 and C2): 1. Check for a nominal 90 degree phase shift between the input and output. 2. Check the capacitors for an open or short.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			3. At the input of the capacitors, the voltage should be 115 volts 400 cps and in phase with the prime power. 4. If the above mentioned voltage is not present, check the wiring and the presence of this voltage coming into the electronics chassis.
		(3) Loss of reference power, 28 volts dc.	(a) Blown fuse - Check front of electronics rack for any illuminated fuseholders and replace with fuse of appropriate type and value. (b) Check for 28 volts dc at the power amplifier XAR2-C with respect to XAR2-A and XAR2-D (ground).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			(c) Check for 28 volts dc at the preamplifier XAR1-A with respect to XAR1-C (ground).
			(d) Check the 470 ohm filter resistor for continuity and the 22 microfarad capacitor for a short. The output of the filter is nominally 24 volts dc.
			(e) Remove the cassette and check for 28 volts dc on the motor control phase center tap. Check at turret connector (pin D, Near Earth Orbital View, Trans-(Earth) View, Mid Moon Orbital View, Trans-Lunar View) (pin K, Trans-Boundary View).
		(4) Gain too low.	(a) Increase the power gain by turning potentiometer A1R1 clockwise.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)		(5) Faulty electrical component.	(a) In the manual mode, rotate the test panel resolver to obtain the maximum error signal at XA1-4. Check for the presence of the correct signal at the following points. If no signal exists at the output of a stage, replace the major component in that stage: 1. Preamplifier - Input XA1-5, a 400 cps sine or clipped sine wave. 2. Power amplifier - Input XA1-8, 400 cps sine or clipped sine wave. Output XAR2-E, 400 cps sine wave with harmonic distortion. 3. Check the motor control phase tuning capacitor (C3) for a short with the power amplifier

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			and output lead to the motor control phase disconnected.
			4. Latching relay K1 - Check the relay for operation and continuity between contacts.
		(6) Faulty mechanical component.	(a) Remove the cassette; and with film and sprocket gears disengaged, rotate the resolver gear, slowly. Binding should not occur.
			(b) Rotate knurled knobs clockwise to turn torque motor and associated gear train. Binding should not occur.
		(7) Mechanical Assembly - Film jammed or off sprocket.	(a) If the film is improperly leaded, refer to film threading instructions on cassette cover plate.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			(b) Insufficient tension on film take-up reel - ac torque motor (cassettes Near Earth Orbital View, Mid Moon Orbital View, Trans-Boundary View): 1. Check for blown fuse on the A8 electronics chassis. 2. With the cassette removed, check the connector (at turret) for a nominal 80 to 160 volt 400 cps, phase shifted 90 degrees on control phase of take-up reel torque motor. **NOTE** Take-up reel is determined by direction of film motion (Near Earth Orbital View, Trans-(Earth) View, pin Y or B to pin S) (Trans-Boundary, pin Y or Z to pin R).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			3. With cassette removed, check at turret connector for 115 volts 400 cps on torque motor reference phase (Near Earth Orbital View, Trans-(Earth) View, pins P to S) (Trans-Boundary View, pins R to S). 4. Check phase shifting capacitors A5C1, A5C2, A5C3, and A5C4 for shorts or opens. 5. Check relays A8A1K3, A8A1K4, and A8A1K2 for proper operation. 6. Reverse flight 28 volts dc boolean signal must be applied to the above relays whenever film is driven in reverse flight direction.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			7. Continuity check from cassette connector to torque motors.
			(c) Insufficient tension on film take-up reel - dc torque motor (cassette Trans-(Earth) View, Trans-Lunar View):
			1. Check for blown fuse on the A18 electronics chassis.
			2. With cassette in place, check for 5 to 7 volts dc from resistors R2 and R3.
			3. Check for nominal 28 volts dc at cassette connector socket, with cassette removed (pin F or J to pin E, ground).
			4. Continuity check from cassette connector to torque motors.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)		(8) Mechanical assembly - Sprocket gear disengaged.	(a) Lightly depress spring loaded gear and rotate resolver gear until both gears mesh.
	b. AC servo is unstable.	(1) Gain too high.	(a) Reduce power gain by turning the power gain control (A1R1) counterclockwise.
		(2) Tachometer signal reversed - Tachometer should be 180 degrees out of phase with the error signal.	(a) Remove cassette and check for tachometer excitation at the turret connector: 1. 115 volts 400 cps high, (all cassettes, pin P, except Trans-Boundary View, pin S). 2. 115 volts 400 cps low, (all cassettes, pin S, except Trans-Boundary View, pin R).

Table 3-7. Trouble Analyss

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)		(3) Loss of tachometer feedback.	(a) With servo running, check for the presence of the tachometer signal at XA1-6: 1. If the signal is present: a. Check for continuity of the tach gain resistor (A1R2). b. Check for continuity between A1R2-R and A1R8. c. Check tachometer summing resistor A1R8 for continuity. d. Check for continuity between A1R8 and XA1-5. 2. If signal is missing (Near-Earth Orbital View, Mid-Moon Orbital View, Trans-Boundary View) during IX operation:

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			a. Check for signal at relay K2, pins 3 and 1. **NOTE** Relay should be in "reset" condition. b. Continuity check from XK2-3 to A2R2 and XK2-1 to A2R1. c. Continuity check for open tach resistor A2R1. d. Continuity check from A2R1 to XA1-6. e. Continuity check for short from XA1-6 to ground. f. Check for signal at backboard and MEP terminals.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			g. Remove cassette and continuity check for open lead on cassette connector (Near-Earth Orbital View and Mid-Moon Orbital View, pins V to F) (Trans-Boundary View, pins H to T). 3. If signal is missing (Near-Earth Orbital View, Mid-Moon Orbital View, Trans-Boundary View) during increased rate operation: a. Continuity check A2R2. b. Check relay K2 for operation. NOTE Relay should be in "set" condition.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			c. Continuity check for open tach resistor A2R1. d. Continuity check from A2R1 to XA1-6. e. Continuity check for short from XA1-6 to ground. f. Check for signal at backboard and MEP terminals. g. Remove cassette and continuity check for open lead on cassette connector (Near-Earth Orbital View and Mid-Moon Orbital View, pins V to F) (Trans-Boundary View, pins H to T). 4. If signal is missing (Trans-(Earth) View, Trans-Lunar View:

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			a. Continuity check for open resistor A2R1. b. Continuity check from A2R1 to XA1-6. c. Continuity check for short from XA1-6 to ground. d. Check for signal at backboard and MEP terminals. e. Remove cassette and continuity check for open lead on cassette connector (Trans-(Earth) View and Trans-Lunar View, pins V to F).
	c. AC servo has a large velocity error.	(1) Gain too low.	(a) Increase the power gain by turning potentiometer A1R1 clockwise.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			(b) If a component is faulty, initially replace the power amplifier. If no change, then replace the preamplifier. If the large error is decreased, then the component replaced is faulty.
		(2) Tachometer gain is too high.	(a) Reduce the tach gain by turning potentiometer A1R2 counterclockwise.
			(b) Check the series tachometer resistor (A2R1 and A2R2) for the correct resistance.
			(c) Check the tachometer summing resistor (A1R8) for the correct resistance.
		(3) Mechanical problems.	(a) If there is binding or excessive friction in the gear train or load, refer to 15.a.(6).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)	d. AC Servo (for cassettes Near-Earth Orbital View, Mid-Moon Orbital View, and Trans-Boundary only.)	(1) Relay K1.	(a) This relay, should be in "reset" state before rewind boolean signal is applied.
		(2) Command not present.	(a) With test panel in manual, apply film rewind command. Check for 28 volts dc at XK1-9. (b) Check for command at backboard. (c) Continuity check from XK1-9 to backboard and backboard to test panel rewind switch.
		(3) Command present.	(a) With test panel in manual, apply film rewind command. Check for 28 volts dc at XK1-9. (b) Check for 28 volts dc on XK1-2: 1. 28 volts dc not present. This is correct condition:

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servo (Cont)			a. Check relay XK1-5 for nominal 1.5 volts, 400 cps. b. Check rewind gain potentiometer (R4) for 3 volts, 400 cps input. c. Continuity and resistance check rewind gain potentiometer (R4). d. Check backboard for 3 volts, 400 cps. NOTE 3 volts 400 cps transformer (A2T1) is located on chassis A18. e. Check A18A2T1 for 3 volts 400 cps output and 115 volts 400 cps input.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
15. MEP AC Servos (Cont)			2. 28 volts dc should not be present at this time. If present, check cassette. Insure that film zero switch actuator is riding on edge of film.
16. MEP Dual Speed AC Servos	a. Dual speed ac servo (attitude, pitch, or yaw axes) runs into or will not come out of either limit. 28 volt indicator light out.	(1) Flipover of wires due to replacement of components.	(a) For the motor control phase, check the wiring from the output of the power amplifier (AR2, pins E and F) to the servomotor terminals 2 and 4. The wire on XAR2-E should be white, and the wire on XAR2-F should be black. (b) For the motor reference phase: 1. Check the wiring from the output of the phase shifting capacitors (C1 and C2) to the servomotor, terminals 1 and 3. The wire from the juction of C1 and C2 should be white.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			2. Check the wiring of the input 115 volts 400 cps to the electronic chassis. On the backboard, the high side should be white and on TB-12. On the backboard the low side should be black and on TB-11.
			(c) For the resolvers:
			1. Check wiring to coarse and fine resolver stator leads (S1 to S3 and S2 to S4).
			2. Check wiring of coarse and fine error leads (R1 and R3).
		(2) Corresponding input signal angle is larger than the maximum allowable signal, as specified on the input signal data drawings. (See section VIII.)	(a) In the automatic mode, check computer coarse and fine input signals at the appropriate test point on the test panel. If the signal is excessive, the computer is at fault.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(b) In the manual mode, only the fine signal is present. Slowly rotate test panel resolver approximately three turns clockwise.
		(3) Open position feedback path.	(a) For faulty resolver wiring or gearing:
			1. Check for coarse and fine resolver output (R1 and R3).
			2. Check for presence of input signal at both resolvers (S1 to S3 and S2 to S4).
			3. Check for continuity from the output leads on the resolvers to pins 1, 2, and 3 on the network assembly (A1).
			4. Check the resolver gearing for slippage. If the gear has slipped, realign the resolver and tighten the clamp.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(b) For faulty summing network (A1): 1. Check feedback summing resistor (A1R5) for correct resistance. 2. Check for continuity between A1R5 and pin 1 of the network assembly (A1). 3. Check zener diodes A1CR1, and A1CR2 for open or short. 4. Check for continuity between A1CR1, anode and pins 2 and 3 of network assembly (A1).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)	b. Dual speed ac servo does not run in auto or manual.	(1) Open or grounded input or resolver feedback signal path.	(a) In manual, check test panel, test points for a signal as resolver is rotated. (Insure that test panel 26 volt 400 cps is on). (b) Check network assembly XA1-1 for varying ac error signal as resolver is rotated: 1. With error signal present at XA1-1, grounded. Check the following points for continuity to ground. Short circuit should not be present: a. Remove the preamplifier (AR1) and check XA1-5, XA1-9, XAR1-F, and XAR1-B.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			b. Remove the power amplifier (AR2) and check XA1-B, XAR2-B, XAR2-E, and XAR2-F. 2. With error signal present at XA1-1, open. Check the following points for continuity: a. Internal to the network assembly (A1) XA1-1 to A1R5, A1R5 to A1R4R, A1R4G to A1R7, A1R7 to XA1-5. b. Check A1R5, A1R4, and A1R7 for correct resistance. c. Output of the tachometer summing junction to the input of the preamplifier XA1-5 to XAR1-F.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			d. Output of the preamplifier to the input of the power gain control XAR1-B to XA1-9. e. Check power gain potentiometer A1R1 for correct resistance. Check A1R1-R to XAR2-8. f. Output of the power gain control to the input of the power amplifier XA1-8 to XAR2-B. g. Output of power amplifier to control phase of motor XAR2-E to white wire on motor terminals 2 or 4, XAR2-F to black wire on motor terminals 2 or 4.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			3. With error signal not present at XA1-1: a. Check for short circuit from XA1-1 to ground. b. Check for error signal at backboard and at fine resolver. c. Check for fine resolver input signals (S1 to S3 and S2 to S4).
		(2) Loss of 115 volt, 400 cps reference power for the reference phase of the servomotor.	(a) Check for presence of voltage at terminals 1 and 3 on the servomotor. The 400 cps voltage should be greater than 75 volt rms. (b) Check for a nominal 90 degree phase shift between the input and the output of the phase shifting capacitors (C1 and C2). (c) Check the phase shifting capacitors (C1 and C2) for an open or short.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(d) Check the input to the phase shifting capacitors (C1 and C2). The voltage should be 115 volt 400 cps and in phase with the prime power. (e) If this voltage is not present, check the wiring and the presence of 115 volt 400 cps coming into the electronics chassis.
		(3) Loss of 28 volt dc reference power.	(a) Blown fuse - Check front of electronics rack for any illuminated fuse holders and replace with fuse of appropriate type and value. (b) Check for 28 volts dc at the power amplifier XAR2-C with respect to XAR2-A and XAR2-D (ground).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(c) Check for 28 volts dc at the preamplifier XAR1-A with respect to XAR1-C (ground). (d) Check the 470 ohm resistor for continuity and the 22 microfarad capacitor for a short. The output of the filter is nominally 24 volts dc. (e) Check for 28 volts dc at the servomotor centertap, terminals 5 and 6, on the servomotor. (f) Check for 28 volts dc on the limit relay XK1-6; attitude, pitch, and yaw axes only. NOTE Altitude roll axis obtains 28 volts dc directly from MEP distribution.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)		(4) Gain too low.	(a) Increase the power gain by turning potentiometer A1R1 clockwise.
		(5) Faulty electrical component.	(a) Apply the maximum input signal in the manual mode and check for the presence of the correct signal at the following points. If no signal exists at the output of a stage, replace the major component in that stage: 1. Preamplifier - Input XA1-5, 400 cps sine wave signal. Output XA1-9, 400 cps sine or clipped sine wave. 2. Power amplifier - Input XA1-8, 400 cps sine or clipped sine wave. Output XAR2-E and F, 400 cps sine wave with harmonic distortion.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			3. Check the motor control phase tuning capacitor (C3) for a short with the power amplifier and output lead to the motor control phase disconnected. 4. Check limit relay (K1) for operation and continuity between contacts (attitude, pitch, and yaw axes only).
		(6) Faulty mechanical component.	(a) Remove the motor gearhead from the assembly; apply the maximum manual mode input signal at the test panel; and check the motor for operation. CAUTION Normal operating temperature is 125^{o} C.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(b) Gearing and load - With the motor removed, manually rotate the input shaft. No binding should occur, and continuity should exist throughout the gear train. If binding exists, remove the last gear pass to the load and recheck gearing and load motion for binding: 1. Load binding - Remove and replace servomotor. 2. Gear binding - Check gears and/or speed reducer for wear or damage and replace faulty components.
	c. Dual speed ac servo is unstable.	(1) Gain too high.	(a) Reduce power gain by turning the power gain control (A1R1) counterclockwise.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(b) In the increased rate mode, check for the proper value of gain reducing resistor (R5), if the unit utilizes a gain reducing resistor.
		(2) Tachometer signal reversed - Tachometer signal should be 180 degrees out of phase with the error signal.	(a) Check the tachometer output on the servomoter. Terminal 7 should be 115 volts, 400 cps high. The wire on terminal 7 should be white. Terminal 10 should be 115 volts, 400 cps low (ground). The wire on terminal 10 should be black.
			(b) Check the tachometer output on the servomotor. Also, check for the correct wiring to terminals 8 and 9 on the servomotor.
		(3) Loss of tachometer signal.	(a) With the servo running, check for the presence of a 400 cps tachometer signal at terminals 8 and 9 on the servomotor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(b) Check for continuity of the series tach resistor A2R1, if the unit utilizes a series tach resistor. (c) Check for shorted zener diode (A2CR1). (d) Check for the presence of the tachometer signal at XA1-6. (e) Check for continuity of the tach gain resistor (A1R2). (f) Check for continuity between A1R2-R and A1R8. (g) Check tachometer summing resistor A1R8 for continuity.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(h) Check for continuity between A1R8 and XA1-5. NOTE Insure that input signal does not exceed maximum velocity and acceleration parameters.
	d. Dual speed ac servo has a large velocity error.	(1) Gain too low.	(a) Increase the power gain by turning potentiometer A1R1 clockwise.
			(b) For faulty component, sequentially replace the power amplifier and preamplifier. If the large error is decreased, then the component replaced is faulty.
		(2) Tachometer gain too high.	(a) Check for open tach limiting zener diode A2CR1.
			(b) Reduce the tach gain by turning potentiometer A1R2 counterclockwise.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(c) Check the series tachometer resistor (A2R1) for the correct resistance.
			(1) Check the tachometer summing resistor (A1R8) for the correct resistance.
		(3) Mechanical problems.	(a) If there is binding or excessive friction in the gear train or load, refer to 16.b. (6).
	e. Dual speed ac servo does not follow input command in auto mode.	(1) Incorrect coarse or fine input signals.	(a) Check for correct coarse and fine input signals at test panel test points.
			(b) Check for fine error signal at network assembly XA1-1 to XA1-3.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			(c) For attitude pitch or yaw axis: 1. Check for coarse error signal at XA1-2 to XA1-7 (ground). 2. Continuity check zener diodes A1CR1 and A1CR2 for open and short. 3. Check wiring of coarse and fine resolver leads. 4. Check zeroing of coarse and fine resolvers. (d) For attitude roll axis: 1. Remove relay (K1), then check for coarse error signal from network assembly XA1-2 to relay socket XK1-3.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			2. If coarse error signal is present: a. Continuity check zener diodes A1CR1 and AR1CR2 for open and short. b. Check wiring of coarse and fine resolver leads. c. Check zeroing of coarse and fine resolvers. 3. If coarse error signal is not present: a. Check from XK1-1 to dc power ground for stick-off voltage. (Adjust potentiometer A3R4 for 2.2 volts, 400 cps.)

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			b. Check secondary of T1-3 to T1-4 (ground) for nominal 2 volt 400 cps.
			c. Check primary of T1 for 50 volts, 400 cps.
			d. Check A3R4-R to ground for 115 volt, 400 cps.
			e. Continuity check A3R4.
			f. Check relay K1 for proper operation.
	f. Dual speed ac servo (attitude roll axis) drives continuously in manual mode.	(1) Loss of 28 volts dc.	(a) Check relay XK1-2 for 28 volts dc. (Set roll axis mode switch on test panel in manual.)
			(b) If 28 volts dc is present:
			1. Continuity check XK1-5 to dc power ground.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
16. MEP Dual Speed AC Servos (Cont)			2. Check relay for proper operation. c. If signal is not present, check test panel for 28 volts dc from roll axis mode switch. 1. Check switch. If bad, remove and replace. 2. If switch is good, check continuity of cabling from switch to power source.
17. MEP DC Drive	a. Quick Dissolve DC Drive does not operate.	(1) No input boolean command.	(a) Set the test panel control to the manual turret II position. (b) In quick dissolve I: 1. Check relay sockets A13A1XK11-2 and A13A1XK14-2 for 28 volts dc.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			2. If the signal is not present, check the wiring according to the diagrams in Section VIII.
			(c) In quick dissolve II:
			1. Check relay sockets A13A4XK7-2 and A13A4XK4-2 for 28 volts dc.
			2. If the signal is not present, check the wiring according to the wiring diagram in Section VIII.
		(2) Loss of power.	(a) In quick dissolve I:
			1. Check relay sockets A13A1XK11-3, A13A1XK12-5, and A13A1XK13-5 for 28 volts dc.
			2. Check relay sockets A13A1XK14-5 and A13A1XK14-8 for continuity to ground.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			3. Check the microswitches on the mechanical assembly for 28 volts dc on terminals N, O and for ground on terminals N and C. 4. Check microswitches A3S1 and A3S2. 5. Check the brake (A3L1) terminal 2 for continuity to ground. (b) In quick dissolve II: 1. Check relay sockets A13A4XK7-3, A13A4XKL-5 for 28 volts dc. 2. Check relay sockets A13A4XK4-8 for continuity to ground. 3. Check the microswitches on the mechanical assembly for

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			28 volts dc, on terminals N and O and for ground on terminals N and C. 4. Check microswitches A5S1 and A5S2. 5. Check the brake (A5L1) terminal 2 for continuity to ground.
		(3) DC torque motor runs continuously, but the mirrors do not move.	(a) Slip clutch setting is too low. Loosen the clamp screw and rotate the clamp clockwise ten degrees. Tighten the clamp screw. If the motor still runs continuously, repeat this procedure.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(b) Microswitches are not activating. Readjust the microswitches on the mechanical assembly, until they activate in the limit.
		(4) Insufficient power.	(a) Power dropping in quick dissolve I, because the resistor setting is too high. Reduce the setting of resistor A13A1A2R4.
			(b) Power dropping is quick dissolve II, because the resistor setting is too high. Reduce the setting of resistor A13A4A2R4.
			(c) Negator spring is not connected. The negator spring should be attached to the quick dissolve assembly operating in the vertical plane.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)		(5) Quick dissolve assembly does not position correctly.	(a) Readjust the microswitches on the mechanical assembly until the mirror assembly comes to rest at the mechanical stops within 0.125 inches.
		(6) Faulty component.	(a) DC troque motor, A3B1, quick dissolve I: 1. Check the motor winding for continuity. 2. Check the output shaft for binding. (b) DC torque motor, A5B1, quick dissolve II: 1. Check the motor winding for continuity. 2. Check the output shaft for binding. (c) Brake, A3L1, quick dissolve I: 1. Check the brake winding for continuity.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			2. With 28 volts dc applied to the brake terminals, the shaft should be free to rotate. 3. With the 0 volts dc applied to the brake terminals, the shaft should be locked. (d) Brake A5L1, quick dissolve II: 1. Check the brake winding for continuity. 2. With 28 volts dc applied to the brake terminals, the shaft should be free to rotate. 3. With 0 volts dc applied to the brake terminals, the shaft should be locked.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(e) For power dropping in quick dissolve I, resistor A13A1A2R4, check for the proper value of resistance and for continuity of the slider. (f) For power dropping in quick dissolve II, resistor A13A4A2R4, check for the proper value of resistance and for continuity of the slider. (g) In quick dissolve I, controlling relays A13A1K11, A13A1K14 and limit relays A13A1K12, A13A1K13: 1. Check the relays for continuity of the coil, pins 2 and 7. (Coil resistance is 300 ohms.)

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			2. Check the relay contacts for continuity in both operating modes.
			(h) In quick dissolve II, controlling relays A13A4K7, A13A4K4 and limit relays A13A4K6, A13A4K5:
			1. Check the relays for continuity of the coil, pins 2 and 7. (Coil resistance is 300 ohms.)
			2. Check the relay contacts for continuity in both operating modes.
			(i) For limit microswitches, A3S1 and A3S2, in quick dissolve I, check for proper operation and continuity.
			(j) For limit microswitches, A5S1 and A5S2, in quick dissolve II, check for proper operation and continuity.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(k) For mechanical gearing: 1. Check the gearing for binding burrs, or misalignment. 2. Check the gears and shafts for slippage. 3. Check the speed reducer for proper operation.
	b. Distortion Lens DC Drive does not operate.	(1) No boolean input command.	(a) In turret No. 1: 1. Set the panel to the "MANUAL IN" position and check relay socket A13A1XK15-2 for 28 volts dc. 2. Check diode for A13A1A1CR11 for continuity. (b) In turret No. 2: 1. Set the test panel to the "MANUAL IN" position and check

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			relay socket A13A4XK9-2 for 28 volts dc.
			2. Check diode A13A4A1CR9 for continuity.
		(2) Loss of power.	(a) In turret No. 1:
			1. Check relay A13A1XK15-3 for 28 volts dc.
			2. Check relay socket A13A1XK15-6 for ground.
			3. Check the microswitches on the mechanical assembly (A2A7S1 and A2A7S2) for 28 volts dc on terminal C.
			(b) In turret No. 2:
			1. Check relay socket A13A4XK9-3 for 28 volts dc.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			2. Check relay socket A13A4XK9-6 for ground.
			3. Check the micro-switches on the mechanical assembly (A4A7S1 and A4A7S2) for 28 volts dc on terminal C.
		(3) Insufficient power.	(a) In turret No. 1, reduce the setting of resistor A13A7A2R5.
			(b) In turret No. 2, reduce the setting of resistor A13A4A2R5.
		(4) Faulty component.	(a) DC torque motor in turret No. 1:
			1. Check the winding of the motor (A2A7B1) for continuity.
			2. Check the output shaft for binding.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(b) DC torque motor in turret No. 2: 1. Check the winding of the motor (A4A7B1) for continuity. 2. Check the output shaft for binding. (c) Turret No. 1 controlling relay A13A1K15 and limit relay A13A1K16: 1. Check the relay for continuity of the coil, pins 2 and 7. (Coil resistance is 300 ohms.) 2. Check the relay contacts for continuity in both operating modes. (d) Turret No. 2 controlling relay A13A4K9 and limit relay A13AK8.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			1. Check the relay for continuity of the coil, pins 2 and 7. (Coil resistance is 300 ohms.) 2. Check the relay contacts for continuity in both operating modes. (e) Turret No. 1 limit resistor A13A1A2R6 and power dropping resistor A13A1A2R5, check for proper resistances and continuity. (f) Turret No. 2 limit resistor A13A4A2R6 and power dropping resistor A13A4A2R5, check for proper resistances and continuity. (g) Turret No. 1 limit microswitches A2A7S1 and A2A7S2, check the microswitches for proper operation and continuity.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(h) Turret No. 2 limit microswitches A4A7S1 and A4A7S2, check the microswitches for proper operation and continuity. (i) For mechanical gearing trouble: 1. Check the gearing for binding, burrs, or misalignment. 2. Check the gears and shafts for slippage. 3. Check the speed reducer for proper operation.
	c. Solar Image Iris DC Drive does not operate.	(1) No input boolean command.	(a) Set the test panel control to the "MANUAL IN" position and check relay socket A13A4XK2-2 for 28 volts dc.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(b) If the signal is not present, check the wiring according to the wiring diagrams in Section VIII.
		(2) Loss of power.	(a) Check the microswitches on the mechanical assembly A12S7 and A12S8 for 28 volts dc on terminal C.
			(b) Check relay socket A13A4XK2-5 and -8 for continuity to ground.
		(3) Faulty component.	(a) For dc torque motor A12B4:
			1. Check the motor winding for continuity.
			2. Check the output shaft for binding.
			(b) For controlling relay A13A4K2:
			1. Check the relay for continuity of the coil pins 2 and 7. (Coil resistance is 300 ohms.)

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			2. Check the relay contacts for continuity in both operating modes. (c) For power dropping resistor A13A4A2R7, check for proper resistance and continuity. (d) For limit microswitches A12S7 and A12S8, check for proper operation and continuity. (e) For mechanical gearing: 1. Check the gearing for binding, burrs, or misalignment. 2. Check the gears and shafts for slippage.
		(4) Solar Image Iris DC Drive does not position correctly.	(a) Check the microswitches on the mechanical assembly A12S7 and A12S8 for proper operation.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(b) Readjust the microswitch that actuates the cam until the dial indicates 25 to 100 percent travel.
	d. Horizon mask dc drive does not operate.	(1) No input boolean command.	(a) Set the test panel control to the "MANUAL OPEN" position and check relay socket A13A4XK3-2 for 28 volts dc.
			(b) If the signal is not present, check the wiring according to the wiring diagrams in Section VIII.
		(2) Loss of power.	(a) Check relay socket A13A4XK3-1 and -4 for 28 volts dc.
			(b) Check relay socket A12A4XK3-5 and -8 for continuity to ground.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)		(3) Faulty component.	(a) For DC torque motor A18A1B1: 1. Check the motor winding for continuity. 2. Check the output shaft for binding. (b) For controlling relay A13A4K3: 1. Check the relay for continuity of the coil pins 2 and 7. (Coil resistance is 300 ohms.) 2. Check the relay contacts for continuity in both operating modes. (c) For limit and power dropping resistors: 1. Check limit resistor A13A4A2R2 for proper resistance and continuity. 2. Check power dropping resistor A13A4A2R3 for proper resistance and continuity of the slider.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(d) Check the limit microswitches A18A1S1 and A18A1S2 for proper operation and continuity.
			(e) For mechanical gearing:
			1. Check the gearing for binding, burrs, or misalignment.
			2. Check the gears and shafts for slippage.
			3. Check the speed reducer for proper operation.
		(4) Motor runs continuously in the limit.	(a) Check resistor A13A4A2R2 for the proper resistance and continuity.
			(b) Check the microswitches on the mechanical assembly (A18A1S1 and A18A1S2) for proper operation.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
17. MEP DC Drive (Cont)			(c) Increase the resistance setting of resistor A13A4A2R3.
		(5) Insufficient power.	(a) Reduce the setting of resistor A13A4A2R3.
18. MEP Solenoid Drive	a. Solenoid drive does not operate.	(1) Loss of power.	(a) Check for 28 volts dc on pin 5 of the relay socket. (b) Check for continuity from the solenoid to ground.
		(2) No input boolean command.	(a) Set the test panel control to the "MANUAL CLOSED" position and check for presence of 28 volts dc at pin 2 of the relay socket. (b) If the signal is not present, check the wiring according to the wiring diagrams in Section VIII.
		(3) Faulty component.	(a) Check the power dropping resistor for continuity and proper resistance.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
18. MEP Solenoid Drive (Cont)			(b) For the controlling relay: 1. Check the relay for continuity of the coil pins 2 and 7. (Resistance is 300 ohms.) 2. Check the relay contacts for continuity in both operating modes. (c) For the rotary solenoid: 1. Check the solenoid winding for continuity. 2. Check the solenoid shutter for mechanical binding. (d) Check the arc suppression diode for short circuit.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
19. Out the Window High Power DC Amplifier	a. Output drifts for a short time when power is applied.	(1) Positive and negative power supply voltages are drifting.	(a) Check CR-4 and CR-5 and replace defective diode.
	b. Zero volt output indicated.	(1) Short circuit in transistors of power amplifier assembly.	(a) Check transistors Q1 to Q12 and replace defective transistors.
	c. Output at a constant voltage.	(1) Failure of components in the preamplifier assembly.	(a) Check the preamplifier and replace the defective components.
	d. Meter offset zero for zero input.	(1) Preamplifier is not balanced.	(a) Check BAL. ADJ. control. (b) Calibrate balance if needed. (Refer to Section VI for calibration and adjustment.)
	e. Power switch does not stay on when operated.	(1) Power supply has a short circuit across the output voltages.	(a) Check CR9 for shorting. (b) Defective transistors in output amplifier heatsink assembly.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
19. Out the Window High Power DC Amplifier (Cont)			(c) Shorts in the power supply assembly. (d) Replace or repair the defective component.
	f. Power switch trips out after operation for short time.	(1) Thermal switches on heatsink are responding to temperatures of about 85°C.	(a) Clean out dust and dirt from fan filter and heatsink assembly.
	g. Protection circuits do not operate.	(1) Improper adjustment. Defective SCR, CR9. Protection circuits on preamplifier assembly.	(a) Check Section VI for adjustment procedures. (b) Check CR9. Check for defective semiconduction components in circuits of protection for preamplifier assembly. (c) Adjust unit or replace defective components.
	h. Protection circuit operates for current in the positive direction only.	(1) Defect among transistors Q3, Q4 or Q8 on preamplifier assembly.	(a) Check Q3, Q4 and Q8. (b) Replace the defective transistor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
19. Out the Window High Power DC Amplifier (Cont)	i. Protection circuit operates for current in the negative direction only.	(1) Defect among transistors Q1, Q2 or Q9 on preamplifier assembly.	(a) Check Q1, Q2 and Q9. (b) Replace the defective transistor.
	j. Severe noise voltages appear in output.	(1) Improper ground connections.	(a) Check over-all ground connections. Connect chassis ground, pin 8 to power ground, pin L.
20. Out the Window Mission Film Power Supply	a. System will not energize in manual mode.	(1) Loss of 3-phase power.	(a) Check for source of power. (b) Replace defective component.
		(2) Lack of 28 volts dc.	(a) Check ±28-volts d-c, relay ground and VP signal (test points TP3 and TP4). (b) Replace defective component.
		(3) Inoperative switch (S1B), relays (K5, K6 and K8).	(a) Check operation of relays. (b) Trace circuit through switch (S1B) to relays (K5, K6 and K8).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
20. Out the Window Mission Film Power Supply (Cont)			(c) Replace defective component.
	b. System will not energize in remote mode.	(1) Lack of VP signal.	(a) Check presence of ±28-volts dc at terminal 2 of terminal board (TB7) and test point (TP4).
			(b) Repair or replace defective part.
		(2) Inoperative switch (S1C).	(a) Trace circuit through terminal 2 of terminal board (TB7) to switch (S1C) and relay (K6).
			(b) Repair or replace defective part.
	c. Supply inoperative, no d-c output.	(1) OUTPUT VOLTAGE and OUTPUT CURRENT meters indicate no d-c power to arc lamp.	(a) Turn equipment off and check fuse (Fe).
		(2) OUTPUT VOLTAGE meter reads 90 volts until IGNITE switch is depressed the falls off.	(a) Check for d-c voltage at test point (TP1). If voltage is not present, check diodes (CR1 thru CR6).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
20. Out the Window Mission Film Power Supply (Cont)			(b) Replace inoperative components.
		(3) Servo drives to full off position and CURRENT ADJ control will not correct.	(a) Turn equipment off and note position of powerstat. In full off, check rectifiers (CR12 thru CR17).
		(4) System will not provide full power.	(a) Check a-c voltage input.
			(b) Check continuity of transformers (T2, T3 and T4).
			(c) Replace defective transformer.
	d. Start voltage does drop out. No signal.	(1) When system is turned on, voltage does not build up beyond 30 volts. Ignition of lamp is difficult.	(a) Check presence of d-c voltage at center tap of variable resistor (R21). If present, check circuit through relay (K2) to test point (TP2). If voltage is not present, check rectifiers (CR18 and CR21) and transformer (T5).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
20. Out the Window Mission Film Power Supply (Cont)	e. System operates but current cannot be changed by either CURRENT ADJ or 1/2 POWER ADJ controls.	(1) Defective relay, powerstat switch or motor.	(a) Rotate CURRENT ADJ control and check operation of relay (K3), powerstat switch and powerstat motor (T7).
	f. System will not respond to 1/2 power command.	(1) Absence of CR signal.	(a) Check for 28-volts d-c VR voltage at terminal 3 of terminal board (TB7) and test point (TP5). (b) Check relay (K4) and trace signal through terminal board (TB7) to contact 13 of relay (K4).
	g. System will not respond to lamp command.	(1) Defective switch or relay.	(a) Check for 28-volt signal at test point (TP6). If present, replace relay (K7). If signal not available, trace circuit from contact 13 of relay (K7) through contacts 3 and 11 of relay (K2) to switch (S1C).
	h. Poor current regulation.	(1) Defective differential amplifier or fluctuating reference signals.	(a) Measure reference voltage to arm of variable resistor (R17) (approximately 1.2 volts dc).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
20. Out the Window Mission Film Power Supply (Cont)			(b) Measure voltage at variable resistors (R17 and R22) for tight arm contact, and zener diode. (CR8). (c) If amplifier is defective, replace with entire new assembly. (d) Check bias and gain of transistors (Q1, Q2, Q3, and Q4) to isolate defective amplifier leg.
21. Out the Window Transboundary Power Supply	a. System will not energize in manaul mode.	(1) Loss of 3-phase power.	(a) Check for source of power. (b) Replace defective component.
		(2) Lack of 28 volt dc.	(a) Check ±28-volt d-c relay ground and VP signal (test points TP3 and TP4). (b) Replace defective component.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
21. Out the Window Transboundary Power Supply (Cont)		(3) Inoperative switch (S1B), relays (K5, K6 and K8).	(a) Check operation of relays.
			(b) Trace circuit through switch (S1B) to relays (K5, K6 and K8).
			(c) Replace defective component.
	b. System will not energize in remote mode.	(1) Lack of VP signal.	(a) Check presence of ±28 volts dc at terminal 2 of terminal board (TB7) and test point (TP4).
			(b) Repair or replace defective part.
		(2) Inoperative switch (S1C).	(a) Trace circuit through terminal 2 of terminal board (TB7) to switch (S1C) and relay (K6).
			(b) Repair or replace defective part.
	c. Supply inoperative, no d-c output.	(1) OUTPUT VOLTAGE and OUTPUT CURRENT meters indicate no d-c power to arc lamp.	(a) Turn equipment off and check fuse (F4).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
		(2) OUTPUT VOLTAGE meter reads 90 volts until IGNITE switch is depressed then falls off.	(a) Check for d-c voltage at test point (TP1). If voltage is present, replace diode (CR7). If voltage is not present, check diodes (CR1 thru CR6) and replace inoperative ones.
		(3) Servo drives to full off position and CURRENT ADJ control will not correct.	(a) Turn equipment off and note position of powerstat. If full off, check rectifiers (CR12 thru CR17).
		(4) System will not provide full power.	(a) Check a-c voltage input.
			(b) Check continuity of transformers (T2, T3 and T4).
			(c) Replace defective transformer.
	d. Start voltage does drop out. No signal.	(1) When system is turned on, voltage does not build up beyond 30 volts. Ignition of lamp is difficult.	(a) Check presence of d-c voltage at centertap of variable resistor (R21).
			(b) If present, check circuit through relay (K2) to test point (TP2).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
21. Out the Window Transboundary Power Supply (Cont)			(c) If voltage is unavailable, check rectifiers (CR18 thru CR21) and transformer (T5).
	e. System operates but current cannot be changed by either CURRENT ADJ or 1/2 POWER ADJ controls.	(1) Defective relay, powerstat switch or motor.	(a) Rotate CURRENT ADJ control and check operation of relay (K3), powerstat switch and powerstat motor (T7).
	f. System will not respond to 1/2 power command.	(1) Absence of VR signal.	(a) Check for 28-volt d-c VR voltage at terminal 3 of terminal board (TB7) and test point (TP5). (b) Check relay (K4) and trace signal through terminal board (TB7) to contact 13 of relay (K4).
	g. System will not respond to lamp command.	(1) Defective switch or relay.	(a) Check for 28-volt signal at test point (TP6). (b) If present, replace relay (K7).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
21. Out the Window Trans-boundary Power Supply (Cont)			(c) If signal not available, trace circuit from contact 13 of relay (K7) through contacts 3 and 11 of relay (K2) to switch (S1C).
	h. Poor current regulation.	(1) Defective differential amplifier or fluctuating reference signals.	(a) Measure reference voltage to arm of variable resistor (R17) (approximately 1.2 volts dc).
			(b) Measure voltage at variable resistors (R17 and R22) for tight arm contact, and zener diode (CR8) (9 volt).
			(c) If amplifier is defective, replace with entire new assembly.
			(d) Check bias and gain of transistors (Q1, Q2, Q3, and Q4) to isolate defective amplifier leg.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
22. Out the Window 400-Watt Solar Power Supply	a. System will not energize in manual mode.	(1) Loss of 3-phase power.	(a) Check for source of power. (b) Replace defective component.
		(2) Lack of 28 volt dc.	(a) Check ±28-volt-dc relay ground and VP signal (test points TP3 and TP4). (b) Replace defective component.
		(3) Inoperative switch (S1B), relays (K5, K6 and K8).	(a) Check operation of relays. (b) Trace circuit through switch (S1B) to relays (K5, K6 and K8). (c) Replace defective component.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
22. Out the Window 400-Watt Solar Power Supply (Cont)	b. System will not energize in remote mode.	(1) Lack of VP signal.	(a) Check presence of ±28 volt dc at terminal 2 of terminal board (TB7) and test point (TP4).
			(b) Repair or replace defective part.
		(2) Inoperative switch (S1C).	(a) Trace circuit through terminal 2 of terminal board (TB7) to switch (S1C) and relay (K6).
			(b) Repair or replace defective part.
	c. Supply inoperative, no d-c output.	(1) OUTPUT VOLTAGE and OUTPUT CURRENT meters indicate no d-c power to arc lamp.	(a) Turn equipment off and check fuse (F4).
		(2) OUTPUT VOLTAGE meters reads 70 volts until IGNITE switch is depressed then falls off.	(a) Check for d-c voltage at test point (TP1).
			(b) If voltage is present, replace diode (CR7).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
22. Out the Window 400-Watt Solar Power Supply (Cont)			(c) If voltage is not present, check diodes (CR1 thru CR6) and replace inoperative ones.
		(3) Servo drives to full off position and CURRENT ADJ control will not correct.	(a) Turn equipment off and note position of powerstat.
			(b) If full off, check rectifiers (CR12 thru CR17).
		(4) System will not provide full power.	(a) Check a-c voltage input.
			(b) Check continuity of transformers (T2, T3, and T4).
			(c) Replace defective transformer.
	d. Start voltage drop out. No signal.	(1) Inoperative relay.	(a) Trun equipment off and check reeds on relay K1 for hang-up.
			(b) Replace relay K2 if relay K1 is operating satisfactorily.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
22. Out the Window 400-Watt Solar Power Supply (Cont)	e. Start voltage inoperative.	(1) When system is turned on, voltage does not build up beyond 50 volts. Ignition of lamp is difficult.	(a) Check presence of d-c voltage at center-tap of variable resistor (R21). (b) If present, check circuit through relay (K2) to test point (TP2). (c) If voltage is unavailable, check rectifiers (CR18 thru CR21) and transformer (T5).
	f. System operates but current cannot be changed by either CURRENT ADJ or 1/2 POWER ADJ controls.	(1) Defective relay, powerstat switch or motor.	(a) Rotate CURRENT ADJ control and check operation of relay (K3), powerstat switch and powerstat motor (T7).
	g. System will not respond to 1/2 power command.	(1) Absence of VR signal.	(a) Check for 28-volt d-c VR voltage at terminal 3 of terminal board (TB7) and test point (TP5). (b) Check relay (K4) and trace signal through terminal board (TB7) to contact 13 of relay (K4).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
22. Out the Window 400-Watt Solar Power Supply (Cont)	h. System will not respond to lamp command.	(1) Defective switch or relay.	(a) Check for 28-volt signal at test point (TP6). (b) If present, replace relay (K7). (c) If signal not available, trace circuit from contact 13 of relay (K7) through contacts 3 and 11 of relay (K2) to switch (S1C).
	i. Poor current regulation.	(1) Defective differential amplifier or fluctuating reference signals.	(a) Measure reference voltage to arm of variable resistor (R17) (approximately 1.2 volts dc). (b) Measure voltage at variable resistors (R17 and R22) for tight arm contact, and zener diode (CR8) (9v). (c) If amplifier is defective, replace with entire new assembly.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
22. Out the Window 400-Watt Solar Power Supply (Cont)			(d) Check bias and gain of transistors (Q1, Q2, Q3, and Q4) to isolate defective amplifier leg.
23. R/D Model, Target Vehicle - Gimbal Mounted	a. Model assembly does not rotate about X-X axis.	(1) Malfunction of servo in model assembly or power supply failure.	(a) Check power inputs. (b) Check wiper brushes. (c) Check torque motor for burnout or frozen state. (d) Check for potentiometer burnout. (e) Check for fan failure. (f) Replace or repair as needed.
	b. Model assembly does not rotate about Y-Y axis.	(1) Malfunction in power supply to drive assembly or in drive mechanism.	(a) Check wiper brushes (2 pair). (b) Check power input.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
23. R/D Model, Target Vehicle - Gimbal Mounted			(c) Check torque motor. (d) Check potentiometers for burnout. (e) If not above, check mechanical assembly. (f) Replace or repair as needed.
	c. Model assembly does not rotate about Z-Z axis.	(1) Malfunction in power supply to drive assembly or in drive mechanism.	(a) Check for wiper brushes not making contact or damage. (b) Check power supply input to drive assembly. (c) Check for motor-generator set burnout. (d) Check potentiometers for burnout. (e) If none of the above, check mechanical assembly.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
23. R/D Model, Target Vehicle - Gimbal Mounted (Cont)			(f) Repair or replace defective components.
24. R/D Model Viewing Closed Loop Television System	a. Panel lamp will not light.	(1) Faulty connection.	(a) Check power connections, F1, S1, and DS1.
	b. No output voltage.	(1) Defective power supply.	(a) Check +8 volt, -8 volt at J1; +6 volt, -6 volt at J1.
			(b) Check oscillator drive module.
	c. No horizontal drive.	(1) Defective oscillator drive module.	(a) Check oscillator drive module.
	d. No vertical drive.	(1) Defective oscillator drive module or binary divider module.	(a) Check oscillator drive module or binary divider module.
	e. No sync.	(1) Defective sync-generator module or binary divider module.	(a) Check sync-generator module or binary module.
	f. No blanking.	(1) Defective sync-generator module.	(a) Check sync-generator module.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
24. R/D Model Viewing Closed Loop Television System (Cont)	g. Unstable output.	(1) Unstable line voltage or defective power regulator module.	(a) Check line voltage and power regulator module.
25. R/D Model Viewing Closed Loop TV System Oscillator Drive Module 8A2A5	a. No output.	(1) Faulty transistor or coil.	(a) Check L1, Q2, Q3, Q4, and Q5.
	b. No XTAL output.	(1) Faulty transistor or crystal.	(a) Check Q2, Q3, and crystal.
	c. No AFC.	(1) Faulty diode or transistor.	(a) Check CR1, CR6 and Q1.
	d. Hook at the top of the picture.	(1) Faulty capacitor.	(a) Check C2.
	e. No horizontal drive.	(1) Faulty transistor.	(a) Check Q6, Q7, Q11, Q12, and Q13.
	f. No vertical drive.	(1) Faulty transistor.	(a) Check 9H in Q8, Q9, and Q10.

Table 3-7. Trouble Analysis (Cont

Unit	Trouble	Probable Cause	Procedure/Remedy
26. R/D Model Viewing Closed Loop TV System Binary Divider Module 8A2A5	a. No output.	(1) Defective component.	(a) Check frequency in binary states (61.38 kc).
	b. Inoperative binary stage.	(1) Defective diode, transistor, or wrong matching of transistors.	(a) Check CR1, CR2, Q1, and Q2.
			(b) Check matching of transistors (inoperative stage).
	c. Wrong count.	(1) Defective transistors or diode.	(a) Check Q4, CR4, Q3, and CR3.
27. R/D Model Viewing Closed Loop TV System Sync Generator Module 8A2A5	a. No output.	(1) Faulty input.	(a) Check pulses in, bias in (osc-drive module).
	b. No 9 horizontal out.	(1) Faulty transistor.	(a) Check Q1.
	c. No vertical blank out.	(1) Faulty diode or transistor.	(a) Check CR3, CR2, Q11 and Q12.
	d. No horizontal blank out.	(1) Faulty diode or transistor.	(a) Check CR1, Q9, and Q10.
	e. No sync out.	(1) Pulses in or faulty transistor.	(a) Check pulses in, Q17, Q15, Q16, Q4, and Q8.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
27. R/D Model Viewing Closed Loop TV System Sync Generator Module 8A2A5 (Cont)	f. Double sync (16.38 kc continuous).	(1) No bias, bias out of adjustment or faulty transistor.	(a) Check bias in, Q4, Q5, Q1, Q2, Q15, and Q16.
	g. Pulse width incorrect. Vertical (serrated).	(1) Faulty transistor, resistor or capacitor.	(a) Check Q15, Q16, R45, and C13.
	h. Normal horizontal sync.	(1) No bias, bias out of adjustment, faulty transistor or resistor.	(a) Check bias in, Q7, Q6, and R41.
	i. Equalizing.	(1) No bias, bias out of adjustment, faulty transistor or resistor.	(a) Check Q3, R6, and bias in.
28. R/D Model Viewing Closed Loop TV System Power Regulator Module 8A2A5	a. +6 volt not regulating.	(1) Faulty diode or transistor.	(a) Check +8 volt, CR4, CR5, Q1, Q2, and Q3.
	b. -6 volt not regulating.	(1) Faulty transistor.	(a) Check -8 volt, +6 volt, Q4, Q6, and Q5.
	c. Out of tolerance after repair.	(1) Voltage too high or too low.	(a) Adjust R4 for -6 volts within 0.1 volts.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
29. R/D Model Viewing Closed Loop TV System Bias Supply 8A2A5	a. No bias.	(1) Faulty capacitor, resistor or diode.	(a) Check C107, C108, CR101, CR102, and R102.
	b. -10 volts not within 0.2 volts.	(1) Faulty diode or out of adjustment.	(a) Check CR108, adjust R105 valve.
30. R/D Slide Viewing Closed Loop TV System	a. Picture not in focus.	(1) Defective tube, resistor or capacitor.	(a) Connect multimeter (item 4, table 3-1) to J1 (7A1A4, 7A2A5) in camera control (2.1 volts). (b) Check resistance of focus coil in camera 7A1A5 and 7A2A7 (10,000 ohms). (c) Replace V17 and check associated parts. Check wiring.
	b. Corners of vidicon picture and center not in focus at the same time.	(1) Defective tube or camera blanking and dynamic focus unit.	(a) Turn vertical focus control R105 in camera control completely clockwise. Picture should not darken in the horizontal center section.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
30. R/D Slide Viewing Closed Loop TV System (Cont)			(b) Replace V14 in camera control.
			(c) Refer to section on blanking and dynamic focus.
	c. Right and left side of vidicon picture and center not in focus at the same time.	(1) Defective tube or camera blanking and dynamic focus unit.	(a) Turn horizontal focus control R37 in camera completely clockwise. Picture should not darken vertically on right and left edges.
			(b) Replace V8 in camera.
			(c) Refer to section on blanking and dynamic focus.
	d. Picture does not show fine detail.	(1) Defective tube or component.	(a) Vary APPER. CORR control R32 on camera control. Turning control clockwise should not result in an increasing of high frequency noise while fine detail increases.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
30. R/D Slide Viewing Closed Loop TV System (Cont)			(b) Replace V5 and V6 in camera control. (c) Isolate other defective components associated with this stage.
	e. Camera retrace lines appearing in picture.	(1) Defective tube or faulty camera blanking and dynamic focus unit.	(a) Turn PEDESTAL SET control in system control clockwise. (b) If picture brightens and retrace lines disappear, replace V14 and V15 in camera control. (c) Refer to blanking and dynamic focus unit analysis.
	f. Bad horizontal streaking in picture.	(1) Defective tube.	(a) Tap tubes in camera and camera control unit. (b) If normal picture results from this procedure replace tube indicating open element.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
30. R/D Slide Viewing Closed Loop TV System (Cont)	g. Increased horizontal streaking.	(1) Defective tube or related components.	(a) Adjust H.F. COMP. capacitor C9 in camera control. (b) If streaking is reduced, replace V2 in camera control. (c) Replace V2 and V4 in camera. (d) Isolate related defective components.
	h. Viewer retrace lines appearing in picture.	(1) Defective camera control video circuit.	(a) Rotate beam control completely counterclockwise; then turn PEDESTAL SET control in system control clockwise. (b) If raster should brighten, retrace lines should disappear - rotate pedestal control R121 clockwise on camera control.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
30. R/D Slide Viewing Closed Loop TV System (Cont)			(c) Refer to camera control video circuits (27).
31. R/D Slide Viewing Closed Loop TV System Sweep Circuits 7A1A4, 7A2A5, 7A1A5, and 7A2A7	a. No video output.	(1) Defective cabling or absence of vertical drive.	(a) Connect vertical input of test oscilloscope (item 2, table 3-1) (a) to TP17 on camera control unit. Refer to figure 3-2 for correct waveform. If indication is normal proceed to 31 a(2).
		(2) Defective tube.	(a) Connect vertical input to TP9. Refer to figure 3-2 for correct waveform. If indication is normal, proceed to 31 a(2) (c). If indication is distorted, replace V14 and V11. If still distorted, proceed to 31 a(2) (b).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
31. R/D Slide Viewing Closed Loop TV System Sweep Circuits 7A1A4, 7A2A5, 7A1A5, and 7A2A7 (Cont)			(b) Connect vertical input to TP8 at camera control. Refer to figure 3-2 for waveform. If indication is normal, isolate defective component using voltage resistance data for V14A. If indication is distorted isolate defective component using voltage resistance data for V11.
			(c) Connect the vertical input to TP12. Refer to figure 3-2 for waveform. If indication is normal proceed to 31 a(4). If indication is distorted, replace V19 and V15. If indication is still distorted proceed to 31 a(3).
		(3) Defective tube, cabling or absence of horizontal drive.	(a) Connect vertical input to TP10. Refer to figure 3-2 for waveform. If indication is distorted, check for defective cabling, or absence of horizontal drive. If indication is

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
31. R/D Slide Viewing Closed Loop TV System Sweep Circuits 7A1A4, 7A2A5, 7A1A5, and 7A2A7 (Cont)			normal, isolate defective component using voltage and resistance data for V15A and V19.
		(4) Defective cabling.	(a) Connect vertical input to TP4 at camera. Refer to figure 3-1 for waveform. If indication is distorted, check for defective cabling. If indication is normal, proceed to 31 a(5).
		(5) Continuity in horizontal deflection transformer, horizontal deflection coil or defective tube.	(a) Connect vertical input to TP5 at camera. Refer to figure 3-1 for waveform. If indication is normal, check continuity in horizontal deflection coil. If measurements are normal, proceed to step 31 a(6). If indication is distorted, replace V6 and V7. If indication is still distorted, isolate defective component using voltage and resistance data for V6 and V7.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
31. R/D Slide Viewing Closed Loop TV System Sweep Circuits 7A1A4, 7A2A5, 7A1A5, and 7A2A7 (Cont)		(6) Defective tube or relay.	(a) Connect multimeter (item 4, table 3-1) to TP11 at camera. A reading of 180 volts should be observed. If indication is normal, replace relay K1. If indication is abnormal, rereplace V9. If still abnormal proceed to 31 a(7).
		(7) Defective tube or diode.	(a) Connect the vertical input to TP10 and TP12 at camera.
			(b) If indication is normal, isolate defective component using voltage and resistance data for V9.
			(c) If indication is not normal, check crystal diodes CR4, CR5 and CR6 and their associated circuits.
32. R/D Slide Viewing Closed Loop TV System Camera Blanking and Synamic Focus	a. No video output.	(1) Defective tube.	(a) Connect vertical input of test oscilloscope (item 2, table 3-1) to TP13 at camera control. Refer to figure 3-2 for waveforms.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
32. R/D Slide Viewing Closed Loop TV System Camera Blanking and Dynamic Focus (Cont)			(b) If indication is distorted replace V14 and V15.
			(c) If vertical blanking pulse is still distorted, proceed to 32 a(2). If
			(d) If vertical parabola is still distorted, with vertical focus R105 maximum clockwise, proceed to step 32 a(3).
			(e) If indication is normal, proceed to 32 a(4).
		(2) Defective tube or hardware in stage.	(a) Connect the vertical input of the test oscilloscope (item 2, table 3-1) to TP8 at camera control. Refer to figure 3-2 for waveform.
			(b) If indication is distorted replace V11.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
32. R/D Slide Viewing Closed Loop TV System Camera Blanking and Dynamic Focus (Cont)			(c) If still distorted isolate defective component using voltage and resistance data for V11.
			(d) If indication is normal, check CR17 and 18, C62, R90 and R96. Use voltage and resistance data for V15B.
		(3) Defective resistor.	(a) Connect the vertical input to pin 7 of V14 at camera control. A vertical parabolic waveform should be present.
			(b) If indication is normal make voltage and resistance measurements for V14B.
			(c) If indication is distorted, check R107, C60, R104 and R105.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
32. R/D Slide Viewing Closed Loop TV System Camera Blanking and Dynamic Focus (Cont)			(c) If indication is distorted, check C48, C47, R61 and R37. (d) If indication is normal proceed to 32 a(6).
		(6) Defective tube or diode.	(a) Set oscilloscope (item 2, table 3-1) for 30 cycles. (b) Connect vertical input to TB termination of yellow V1 cathode lead. (c) If indication is normal, circuit is operating properly. (d) If indication is distorted replace V8. (e) If still distorted check CR2, CR3. (f) If still abnormal, isolate faulty component using voltage and resistance measurements for V8.
33. R/D Slide Viewing Closed Circuit TV Camera Video Circuits	a. No video output.	(1) Defective tube or associated component.	(a) Connect test oscilloscope (item 2, table 3-1) vertical input TP2 at camera. Refer to figure 3-1 for waveform. (b) If indication is distorted, proceed to step 33 a(2).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
32. R/D Slide Viewing Closed Loop TV System Camera Blanking and Dynamic Focus (Cont)		(4) Faulty connection.	(a) Set oscilloscope (item 2, table 3-1) for 30 cycle sweep. (b) Connect vertical input of oscilloscope to TP9 at camera. Refer to figure 3-2 for waveform. (c) If indication is distorted, check for faulty connection at J1 of camera and J1 of camera control. (d) If indication is normal, proceed to 26 a(5).
		(5) Defective resistor or capacitor.	(a) Set oscilloscope (item 2, table 3-1) for 13 kc sweep. (b) Connect vertical input of oscilloscope to TP7 at camera. Refer to figure 3-2 for waveform.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
33. R/D Slide Viewing Closed Circuit TV Camera Video Circuits (Cont)			(c) If indication is normal, replace V5 and check waveform at TP1.
			(d) If indication is still distorted, isolate defective component using voltage and resistance data for V5.
		(2) Defective tube.	(a) Connect voltmeter (item 1, table 3-1) to TP1 at camera. Between 20 and 100 volts should be read. If indication is normal, replace V4 and repeat 33 a(1). If indication in 33 a(1) is still abnormal isolate defective component using voltage and resistance data for V2, V3, andV4. If indication is still abnormal proceed to trouble analysis of vidicon camera tube.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
33. R/D Slide Viewing Closed Circuit TV Camera Video Circuits (Cont)		(3) Defective tube and/or associated hardware.	(a) Connect vertical input of test oscilloscope (item 2, table 3-1) to TP2 on camera control unit. Refer to figure 3-1 for waveform. If indication is normal, proceed to 33 a(4). If indication is distorted, replace V1, V2, and V3. If indication at TP2 is still distorted, isolate defective component using voltage and resistance data for V1, V2 and V3. (b) Connect the vertical input to TP4 at camera control. Refer to figure 3-1 for waveforms. If indication is normal proceed to 33 a(3) (c). If indication is distorted, replace V4 and V5. If indication at TB3 is still distorted isolate defective component using voltage and resistance data V3B, V4 and V5A.

Table 3-7. Trouble Anylisis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
33. R/D Slide Viewing Closed Circuit TV Camera Video Circuits (Cont)			(c) Connect vertical input of oscilloscope (item 2, table 3-1) to TP4 on camera control unit. Refer to figure 3-1 for waveform. If indication is distorted, replace V6. If indication at TP4 is still distorted, isolate defective component using voltage and resistance data for V6B.
		(4) Defective tube.	(a) Connect vertical input of oscilloscope (item 2, table 3-1) to TP5 at camera control unit. Refer to figure 3-1 for waveform. If indication is normal, unit is operative. If waveshape is correct but amplitude is low proceed to 33 a(7). If indication is otherwise distorted proceed to 33 a(8).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
33. R/D Slide Viewing Closed Circuit TV Camera Video Circuits (Cont)			(b) Connect vertical input of oscilloscope to TP6 on camera control unit. Refer to figure 3-1 for waveform. If indication is distorted replace V9 and V10. If indication is still distorted isolate defective component using voltage and resistance data for V9 and V10. (c) Connect the vertical input of the test oscilloscope (item 2, table 3-1) to TP5 at the camera control unit. Refer to figure 3-1 for waveform. If the indication is distroted, replace V7 and V8. If indication is still distorted, proceed to 33 a(5).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
33. R/D Slide Viewing Closed Circuit TV Camera Video Circuits (Cont)		(5) Blanking circuit.	(a) Connect the vertical input of the test oscilloscope (item 2, table 3-1) to TP14 on the camera control unit. Refer to figure 3-2 for waveform. If indication is normal, proceed to step 33 a(6) (c). If indication is distorted, check blanking circuit in pulse generator.
		(6) Defective tube and/or associated circuitry.	(a) Connect the vertical input to TP15 on the camera control unit. Refer to figure 3-2 for waveform. If indication is normal go to 33 a(7). If indication is distorted, replace V20. If indication is still distorted, make voltage and resistance measurements for V20.
		(7) Horizontal output circuit of the pulse generator.	(a) Connect the vertical input to TP10 on the camera control unit. Refer to figure 3-2 for waveform. If the indication is

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
33. R/D Slide Viewing Closed Circuit TV Camera Video Circuits (Cont)			distorted, check the horizontal output circuit of the pulse generator.
		(8) Defective tube and/or associated hardware.	(a) Connect the vertical input of the test oscilloscope (item 2, table 3-1) to TP7. Refer to figure 3-2 for waveform. If the indication is normal, proceed to 33 a(a). If the indication is distorted, replace V15 and V19. If indication is still distorted, make voltage and resistance measurements on V15A and V19.
		(9) Defective tube, diode and/or associated hardware.	(a) Connect the vertical input of the test oscilloscope (item 2, table 3-1) to TP5. Refer to figure 3-1 for waveform. If indication

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
33. R/D Sliding Viewing Closed Circuit TV Camera Video Circuits (Cont)			is still distorted, replace V18. If indication is still distorted make voltage and resistance measurements for V7, V8A, and V18. If voltage and resistance measurements are normal, replace CR3; then CR4.
34. R/D Slide Viewing Closed Loop TV System Vidicon Camera Tube	a. No video output.	(1) Defective resistor.	(a) Place power switch in "OFF" position. Disconnect cable at J1 of camera. Disconnect vidicon tube connector. **WARNING** Discharge voltage between J1-21 of camera cable and ground. (b) Set scale of multimeter (item 4, table 3-1) to 10K ohms and measure resistance between pin 6 of vidicon connector and J1-21 of camera. (51K±2.5K ohms.) If indication is abnormal, replace resistor R48.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
34. R/D Slide Viewing Closed Loop TV System Vidicon Camera Tube (Cont)		(2) Defective vidicon tube.	(a) Check for continuity between pins 1 and 8 at the neck of vidicon camera tube. If indication is abnormal, replace vidicon camera tube.
		(3) Defective resistor.	(a) Measure the resistance between pin 2 at the vidicon connector and J1-8 at the camera (100K ±5K ohms). If indication is abnormal replace resistor R49.
			(b) Measure the resistance between pin 4 of relay K1 at camera and ground (570K ±31K ohms). If indication is abnormal, check resistors R50 and R51.
			(c) Measure the resistance between pin 7 of the vidicon connector and ground (3.3K ±160 ohms). If indication is abnormal, replace resistor R47.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
34. R/D Slide Viewing Closed Loop TV System Vidicon Camera Tube (Cont)		(4) Defective focus coil.	(a) Measure the resistance between pins 10 and 17 of J1 at the camera. (10K ±1K ohms). If indication is abnormal, replace focus coil L5. (Remove vidicon camera tube before attempting to replace focus coil). If all resistance measurement indications are normal, proceed to 28 a(7).
		(5) Defective power supply or vidicon tube.	(a) Turn focus control at system control counterclockwise. Set scale of multimeter to 1200 VDC and connect test leads to J1-21 and J1-18 (ground). WARNING High voltage. (b) Place power switch in "ON" position. A reading of 900 volts dc should be read. If indication is abnormal check the 900 volt power supply. If indication is normal, place the power

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
34. R/D Slide Viewing Closed Loop TV System Vidicon Camera Tube (Cont)			switch on "OFF" position, reconnect cable to J1 at camera, and replace vidicon camera tube (Section III).
35. R/D Waveform Monitor (7A2A3)	a. Scale illuminator pilot light, and tube heaters do not light.	(1) Line power not applied, fuse (F601), power switch (SW601), power transformer T601 defective.	(a) Check to see if oscilloscope is properly connected to power source. (b) Check for correct line voltage between terminals 1 and 4 of T601. (c) If line voltage correct, T601 is probably defective. (d) If abnormal, F601 or SW601 is probably defective.
	b. No video waveform display or trace on the screen with INPUT switch set to either "A" or "B".	(1) Loss of video signal.	(a) Check the signal source for 0.25 volts or more signal. Set the SYNC. switch to "INT". If normal, proceed to 35 b(1) (b). If abnormal, apply proper amplitude video signal to "video input A" connector.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
35. R/D Waveform Monitor (7A2A3) (Cont)			(b) Set INPUT switch to "CAL.", CALIBRATOR switch to ".74"; DISPLAY switch ".125 h/cm" and MAGNIFIER to "X1". The calibrator waveform should appear. If normal, troubleshoot from the video connectors to INPUT switch SW404. If abnormal, proceed to 29 b (1) (c). (c) Check for correct regulated power supply output voltages for all supplies including the -3800 volt supply. If normal, proceed to 29 b(1) (d). If abnormal and one or more of the power-supply voltages are improper, check the supply. (d) Short vertical deflection plates to gather with jumper lead. Trace should appear. If normal, remove jumper and proceed to check stage.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
35. R/D Waveform Monitor (7A2A3) (Cont)			If abnormal, remove the lead and proceed to 29 b(1) (e). (e) Apply correct amplitude sync pulses to "ext. nec. sync. input" connector. Set INPUT switch to "A" with signal applied to "video input A". Video input should appear. If normal, troubleshoot internal sync amplifier stage V14. Check for waveform at pin 7 of V35. If distorted proceed to next 35 b(1) (f). (f) Check waveform at pin 8, V161 and pin 1, V145 (figure 3-3) in the sweep generator. If normal proceed to 35 b(1) (2). If normal proceed to 35 b(1) (g). If abnormal, check to see if waveform at pin 8, V161 is normal but waveform at pin 1, V145 is abnormal. If so, check waveform at pin 1 of V145B. Normal waveform unblanks the CR1 and permits waveform to be displayed. If neither waveform appears, measure the

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
35. R/D Waveform Monitor (7A2A3) (Cont)			voltage at pin 8 of V161. If the sweep has not started, the voltage should be +180 volts. If abnormal, check tubes in feedback loop. (g). Up to this point, the only main circuit that remains to be checked is the horizontal amplifier circuit. To check, remove V384. A vertical trace should appear that varies in amplitude according to signal change. If normal, check horizontal amplifier. If distorted check CRT.
36. R/D ETA Servo	a. No voltage swing.	(1) No input voltage, defective amplifier, or shorted diode or transistor.	(a) Check the green TP in the first stage amplifier involved with the servo. A plus or minus 10 volt swing should be noted. If not, refer to the power systems concerning the 10 volt distribution.
	b. Ten volt swing present but no output variance.	(1) Poorly seated amplifier card or defective amplifier.	(a) Push in each card associated with the servo to be sure it is properly seated. The check the output again. If still no response,

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
36. R/D ETA Servo (Cont)			move test probe to TP1 on summing card. An output swing of plus or minus 10 volts should be observed. This is the output of the first amplifier. Follow this procedure through the system and if an amplifier is encountered in which there is no voltage swing it may be assumed that the amplifier itself is defective.
	c. Saturation in either the plus or minus direction (uncontrollable fixed voltage of plus or minus 50 volts dc).	(1) Shorted diode, transistor, resistor with low valve or amplifier malfunction.	(a) Remove the preamplifier or driver associated with the test point, and check the following components: Q104 or Q105 emitter to collector bidirectionally. One or both may be shorted. If Q104 or Q105 is shorted change both.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
36. R/D ETA Servo (Cont)			R115 must read close to 180 ohms. If R115 is lower than 180 ohms it must be replaced. Check CR103 and 104 for shorting. If the condition still exists and all the preamplifiers function correctly, the power amplifier is next to be examined. If CR103 or 104 is shorted, both must be changed. Check the fuses of the amplifier for possible burn out.
	d. Servo is operating bi-directionally but speeds in both directions are unequal.	(1) Defective diodes CR5, CR6, or CR7.	(a) Put servo in manual mode by turning "Auto-Man." switch on control panel to "MAN." position. Use an oscilloscope (item 2, table 3-1) to check each of the Donner amplifiers and note their output voltages while rotating the servo from one extreme to the other. Amplifiers 6A2A2A4 and 6A2A2A1 have similar zener diodes across their feedback

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
36. R/D ETA Servo (Cont)			resistors. Check CR5, 6, and 7 with an ohmmeter on the X10,000 range. Check the resistance bidirectionally across the zener diodes. (Approximately 100K ohms.) If there is a large difference in readings for a diode, it must be replaced.
	e. Servo drives uncontrollably to either end.	(1) Short circuit in amplifier.	(a) Check the output of amplifiers 6A2A2A5, 6A2A2A1, 6A2A2A3 and 6A2A24 for a short circuit voltage of ±50 VDC. (b) Quickly remove the amplifier and make an in-circuit check of the two 2N2405 transistors. This is to be done with an ohmmeter (item 4, table 3-1) on low range. Check these transistors bidirectionally for emitter-collector resistance.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
36. R/D ETA Servo (Cont)			If either show short circuit, change both. (c) Check CR103 and 104. If either is shorted, change both. (d) Examine R115 (180 ohms). The in-circuit resistance should be 180 ohms. If this reads below this value, replace it.
	f. Servos stop entirely.	(1) Output short circuit or high amplitude oscillations.	(a) Check fuses F1, F2 and F3 on 6A2A2A6. If a fuse has "blown" remove the amplifier and make an in-circuit, bidirectional check of transistors Q1 and Q2. An ohmmeter (item 4, table 3-1) on low range should be utilized for this check of emitter-collector resistance. Check the resistance between TP1 on power amplifier 6A2A2A6 and ground with an ohmmeter.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
36. R/D ETA Servo (Cont)			A reading between 600 and 800 ohms is normal. If the resistance is much less, check the load circuitry.
	g. Servo drive uncontrollable through 180° and acts normal for the other 180°.	(1) Defective potentiometer.	(a) Remove power amplifier 6A2A2A6 fuses F1, F2 and F3. (b) With a Millivac (item 5, table 3-1) or equivalent, check pins 2 of "B" and "C" section of the follow up pot while manually rotating the servo. The voltage should swing ±10 volts dc on each section. Each No. 2 pin should null at a point 180 degrees from each other. If not, check the 1 and 3 terminals for plus and minus 10 volts dc. If pins 1 and 3 show the proper voltage (±10 volts dc) and pin 2

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
36. R/D ETA Servo (Cont)			shows only one polarity or none, the potentiometer is defective.
	h. Servo torque is normal on MAN. but has little or no torque on AUTO.	(1) High internal resistance on the wiper arm circuit (No. 2 pin) of the 3 ganged follow-up potentiometers (A section).	(a) Check potentiometer.
	i. Loss of output.	(1) Poorly seated cards.	(a) Check all cards to be sure they are properly seated. Ultimate operation of amplifiers depends on careful installation.
	j. Lower than normal output voltage.	(1) Maladjustment of gain or defect in feedback potentiometers.	(a) Check output of power amplifier 6A2A2A6 and feedback potentiometer. Adjust gain or replace defective potentiometer.
	k. Low frequency oscillation of servo.	(1) Follow-up voltage has been lost.	(a) Remove the fuses from the power amplifier and check No. 2 pins of section "B" and "C" of the follow-up potentiometer, and while manually rotating servo, a null should be noted

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
36. R/D ETA Servo (Cont)			180° between the two potentiometers. During rotation, check the presence of ±10 volts dc on pins 1 and 3 of "B" and "C" sections. If the null is not noted, the potentiometer must be replaced.
	1. High speed operation with attempt to position.	(1) Loss of tachometer voltage may have been caused by a short circuit of the tachometer generator, loss of generator voltage, and/or shearing of the generator coupling.	(a) Check the coupler between the motor and generator.
37. R/D ZETA Servo	a. No voltage swing.	(1) No input voltage, defective amplifier or shorted diode or transistor.	(a) Check the green TP in the first stage amplifier involved with the servo. A plus or minus 10 volt swing should be noted. If not, refer to the power systems concerning the 10 volt distribution.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
37. R/D ZETA Servo (Cont)			If swing is noted, refer to 31 b.
	b. 10 volt swing present but no output variance.	(1) Poorly seated amplifier card or defective amplifier.	(a) Push in each card associated with the servo to be sure it is properly seated. Then check output again. (b) If still no response, move test probe to TP1 on summing card. An output swing of plus or minus 10 volts should be observed. This is the output of the first amplifier. (c) Follow this procedure through the system; and if an amplifier is encountered in which there is no voltage swing, it may be assumed that the amplifier itself is defective.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
37. R/D ZETA Servo (Cont)	c. Saturation in either the plus or minus direction (uncontrollable fixed voltage or plus or minus 50 volts dc).	(1) Shorted diode, transistor, resistor with low value or amplifier malfunction.	(a) Remove the preamplifier or driver associated with the test point and check the following components: Q104 or Q105 emitter to collector bidirectionally. One or both may be shorted. If Q104 or Q105 is shorted, change both. (b) R115 must read close to 180 ohms. If R115 is much lower than 180 ohms it must be replaced. (c) Check CR103 and 104 for shorting. (d) If condition still exists and all the preamplifiers function correctly, the power amplifier is next to be examined. (e) If CR103 or CR104 is shorted both must be changed.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
37. R/D ZETA Servo (Cont)			(f) Check the amplifier fuses for possible burn out.
	d. Servo is operating bidirectionally but speeds in both directions are unequal.	(1) Defective diodes CR5, CR6, CR7.	(a) Put servo in manual mode by turning "Auto-Man." switch on control panel to "MAN." position. Use an oscilloscope (item 2, table 3-1) to check each of the Donner amplifiers and note their output voltages while rotating the servo from one extreme to the other.
			(b) Amplifiers 6A2A2A9, 6A2A2A10 and 6A2A2A12 have similar zener diodes across their feedback resistors.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
37. R/D ZETA Servo (Cont)			(c) Check CR5, CR6 and CR7 with an ohmmeter (item 4, table 3-1) on the X10,000 range. Check the resistance bidirectionally across the zener diodes. (Approximately 100K ohms.) If there is a large difference in readings for a diode, it must be replaced.
	e. Servo drives uncontrollably to either end.	(1) Short circuit in amplifier.	(a) Check the output of amplifiers 6A2A2A8, 6A2A2A9, 6A2A2A10, and 6A2A2A12 for a short circuit voltage of ±50 volts dc.
			(b) Quickly remove the amplifier and make an in-circuit check of the two 2N2405 transistors. This is to be done with an ohmmeter (item 4, table 3-1) on low range. Check these transistors bidirectionally for emitter-collector resistance. If either show short circuit, change both.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Proceudre/Remedy
37. R/D ZETA Servo (Cont)			(c) Check CR103 and CR104. If either is shorted, change both. (d) Examine R115 (180 ohms). The in-circuit resistance should be 180 ohms. If this reads below this value, replace it.
	f. Servos stop entirely.	(1) Output short circuit or high amplitude oscillations.	(a) Check fuses F1, F2, and F3 on 6A2A2A7. (b) If a fuse has "blown" remove the amplifier and make an in-circuit, bidirectional check of transistors Q1 and Q2. An ohmmeter (item 4, table 3-1) on low range should be utilized for this check of emitter-collector resistance. (c) Check the resistance between TP1 on the power amplifier 6A2A2A7 and ground with an ohmeter. A

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
37. R/D ZETA Servo (Cont)			reading between 600 and 800 ohms is normal. If the resistance is much less check the load circuitry.
	g. Servo drive uncontrollable through 180 degrees and acts normal for the other 180 degrees.	(1) Defective potentiometer.	(a) Remove power amplifier fuses F1, F2, and F3. With a Millivac (item 5, table 3-1) or equivalent, check pins 2 of "B" and "C" section of the follow-up potentiometer while manually rotating servo. The voltage should swing ±10 volts dc on each section. Each No. 2 pin should null at a point 180 degrees from each other. If not, check the 1 and 3 terminals for plus and minus 10 volts dc. If pins 1 and 3

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
37. R/D ZETA Servo (Cont)			show the proper voltage (±10 volts dc) and pin 2 shows only one polarity or none, the potentiometer is defective.
	h. Servo torque is normal on MAN. but has little or no torque on AUTO.	(1) High internal resistance on the wiper arm circuit (No. 2 pin) of the 3 ganged follow up potentiometers (A section).	(a) Check potentiometer.
	i. Loss of output.	(1) Poorly seated cards.	(a) Check all cards to be sure they are properly seated. Ultimate operation of amplifiers depends on careful installation.
	j. Lower than normal output voltage.	(1) Maladjustment of gain or defect in feedback potentiometers.	(a) Check output of power amplifier 6A2A2A6 and feedback potentiometer. Adjust gain or replace defective potentiometer.
	k. Low frequency oscillation of servo.	(1) Follow-up voltage has been lost.	(a) Remove the fuses from the power amplifier and check No. 2 pins of section

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
37. R/D ZETA Servo (Cont)			"B" and "C" of the follow-up potentiometer and while manually rotating servo, a null should be noted 180 degrees between the two potentiometers. During rotation, check the presence of ±10 volts dc on pins 1 and 3 of "B" and "C" sections. If the null is not noted, the potentiometer must be replaced.
	1. High speed operation with little attempt to positon.	(1) Loss of tachometer voltage, may have been caused by a short circuit of the tachometer generator loss of generator voltage and/or shearing of the generator coupling.	(a) Check the coupler between the motor and generator.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
38. R/D Xi Vehicle Drive Assembly	a. Electrical breakdown.	(1) Motor burnout.	(a) Check input voltage.
		(2) Potentiometer burnout, or wiper wear and shorting.	(b) Check potentiometer and wipers for shorting and wear. Check circuit for continuity.
39. R/D Xi Servo	a. No voltage swing.	(1) No input voltage, defective amplifier, or shorted diode or transistor.	(a) Check the green TP in the first stage amplifier involved with the servo. A plus or minus 10 volt swing should be noted. If not, refer to the power systems concerning the 10 volt distribution. If swing is noted refer to 33b.
	b. 10 volt swing present but no output variance.	(1) Poorly seated amplifier card or defective amplifier.	(a) Push in each card associated with the servo to be sure it is properly seated. Then check output again.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
39. R/D X1 Servo (Cont)			(b) If still no response move test probe to TP1 on summing card. An output swing of plus or minus 10 volts should be observed. This is the output of the first amplifier.
			(c) Follow this procedure through the system and if an amplifier is encountered in which there is no voltage swing it may be assumed that the amplifier itself is defective.
	c. Saturation in either the plus or minus direction (Uncontrollable fixed voltage of plus or minus 50 volts dc.)	(1) Shorted diode, transistor, resistor with low value or amplifier malfunction.	(a) Remove the preamplifier or driver associated with the test point and check the following components: Q104 or Q105 emitter to collector bidirectionally. One or both may be shorted. If Q104 or Q105 is shorted change both.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
39. R/D X1 Servo (Cont)			(b) R115 must read close to 180 ohms. If R115 is much lower than 180 ohms it must be replaced. (c) Check CR103 and CR104 for shorting. (d) If condition still exists and all the preamplifiers function correctly, the power amplifier is next to be examined. (e) If CR103 or CR104 is shorted both must be changed. (f) Check amplifier fuses for possible burn out.
	d. Servo is operating bidirectionally but speeds in both directions are unequal.	(1) Defective diodes CR5, CR6, or CR7.	(a) Put servo in manual mode by turning "Auto-Man." switch on control panel to "MAN." position.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
39. X1 Servo (Cont)			(b) Use an oscilloscope (item 2, table 3-1) to check each of the Donner amplifiers and note their output voltages while rotating the servo from one extreme to the other. (c) Amplifiers 6A2A3A1, 6A2A3A3 and 6A2A3A6 have similar zener diodes across their feedback resistors. Check CR5, CR6 and CR7. With an ohmmeter (item 4, table 3-1) on the X10,000 range, check the resistance bidirectionally across the zener diodes. (Approximately 100K ohms.) If there is a large difference in readings for a diode, replace it.
	e. Servo drives uncontrollably to either end.	(1) Short circuit in amplifier.	(a) Check output of amplifiers 6A2A3A5, 6A2A3A1, 6A2A3A3, and 6A2A3A4 for a short circuit voltage of ±50 volts dc.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
39. R/D X1 Servo (Cont)			(b) Quickly remove the amplifier and make an in-circuit check of the two 2N2405 transistors. This is to be done with an ohmmeter (item 4, table 3-1) low range. Check these transistors bidirectionally for emitter-collector resistance. If either show short circuit, change both. (c) Check CR103 and CR104. If either is shorted, change both. (d) Examine R115 (180 ohms). The in-circuit resistance should be 180 ohms. If this reads below this value, replace it.
	f. Servos stop entirely.	(1) Output short circuit or high amplitude oscillations.	(a) Check fuses F1, F2, and F3 on 6A2A3A6.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
39. R/D X1 Servo (Cont)			(b) If a fuse has "blown" remove the amplifier and make an in-circuit, bidirectional check of transistors Q1 and Q2. An ohmmeter (item 4, table 3-1) on low range should be utilized for this check of emitter-collector resistance.
			(c) Check the resistance between TP1 (on the power amplifier 6A2A3A6) and ground with an ohmmeter. A reading between 600 and 800 ohms is normal. If the resistance is much less check the load circuitry.
	g. Servo drive uncontrollable through 180 degrees and acts normal for the other 180 degrees.	(1) Defective potentiometer.	(a) Remove power amplifier 6A2A3A6 fuses F1, F2, and F3. With a Millivac (item 5, table 3-1) or equivalent, check pins 2 of section "B" and "C" of the follow-up potentiometer while manually rotating the servo. The voltage should swing ±10 volts

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
39. R/D Servo (Cont)			dc on each section. Each No. 2 pin should null at a point 180 degrees from each other. If not, check the 1 and 3 terminals for plus and minus 10 volts dc. If pins 1 and 3 show the proper voltage (±10 volts dc) and pin 2 shows only one polarity or none, the potentiometer is defective.
	h. Servo torque is normal on MAN. but has little or no torque on AUTO.	(1) High internal resistance on the wiper arm circuit (No. 2 pin) of the 3-ganged, follow-up potentiometers (A section).	(a) Check potentiometer.
	i. Loss of output.	(1) Poorly seated cards.	(a) Check all cards to be sure they are properly seated. Ultimate operation of amplifiers depends on careful installation.
	j. Lower than normal output voltage.	(1) Maladjustment of gain or defect in feedback potentiometers.	(a) Check output of power amplifier 6A2A3A6 and feedback potentiometer. Adjust gain or replace defective potentiometer.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
39. R/D Servo (Cont)	k. Low frequency oscillation of servo.	(1) Follow-up voltage has been lost.	(a) Remove the fuses from the power amplifier and check No. 2 pins of section "B" and "C" of the follow-up potentiometer, while manually rotating the servo; a null should be noted 180° between the two potentiometers. During rotation, check the presence of ±10 volts dc on pins 1 and 3 of "B" and "C" sections. If the null is not present, the potentiometer must be replaced.
	l. High speed operation with little attempt to position.	(1) Loss of tachometer voltage, may have been caused by a short circuit of the tachometer generator, loss of generator voltage, and/or shearing of the generator coupling.	(a) Check the coupler between the motor and generator.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
40. R/D Rotational Sun Track Drive	a. Electrical breakdown.	(1) Motor burnout.	(a) Check input voltage.
		(2) Potentiometer burnout, wiper wear, and shorting.	(b) Check potentiometer and wipers for shorting and wear.
	b. Loose chain Drive.	(1) Low spring tension.	(a) Check spring drive for play; take up spring tension by adjusting the rod holding spring end.
	c. Sun ring gimbal not rotating.	(1) Lack of power to input of servo.	(a) Check input voltage.
	d. Sun ring gimbal not running smoothly.	(1) Signal input jumpy or shorts in potentiometers or motor-generator set friction.	(a) Check potentiomenters and motor-generator sets; check for bad bearings, bad gearing or clutch slipping.
41. R/D Sun Rotational Servo	a. No voltage swing.	(1) No input voltage, defective amplifier, or shorted diode or transistor.	(a) Check the green TP in the first stage of the amplifier involved with the servo. A plus or minus

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
41. R/D Sun Rotational Servo (Cont)			10 volt swing should be noted. If not, refer to the power systems concerning the 10 volt distribution. If swing is noted proceed to 35b.
	b. 10 volt swing present but no output variance.	(1) Poorly seated amplifier card or defective amplifier.	(a) Push each card associated with the servo to be sure it is properly seated. Re-check output. (b) If still no response move test probe to TP1 on summing card; an output swing of plus or minus 10 volts should be observed. This is the output of the first amplifier. (c) Follow this procedure through the system and if an amplifier is encountered in which there is no voltage swing it may be assumed that the amplifier itself is defective.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
41. R/D Sun Rotational Servo (Cont)	c. Saturation in either the plus or minus direction (uncontrollable fixed voltage of plus or minus 50 volts dc).	(1) Shorted diode, transistor, resistor with low value or amplifier malfunction.	(a) Remove the preamplifier or driver associated with the test point and check the following components: Q104 or Q105 emitter to collector bidirectionally. One or both may be shorted. If Q104 or Q105 is shorted change both. (b) R115 must read close to 180 ohms. If it is much lower than 180 ohms it must be replaced. (c) Check CR103 and CR104 for shorting. If CR103 or CR104 is shorted both must be changed. (d) If condition still exists and all the preamplifiers function correctly, examine the power amplifier for possible burned out fuses.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
41. R/D Sun Rotational Servo (Cont)	d. Servo is operating bidirectionally but speeds in both directions are unequal.	(1) Defective diodes CR5, CR6, or CR7.	(a) Put servo in manual mode by turning the "Auto-Man." switch on the control panel to the "MAN." position. (b) Use an oscilloscope (item 2, table 3-1) to check each of the Donner amplifiers and note their output voltages while rotating the servo from one extreme to the other. (c) Amplifiers 6A2A3A12, 6A2A3A10, and 6A2A3A9 have similar zener diodes across their feedback resistors. Check CR5, CR6, and CR7 with an ohmmeter (item 4, table 3-1) on the X10,000 range. Check the resistance bidirectionally across the zener diodes. (Approximately 100K ohms.) If there is a large difference in readings replace the diode.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
41. R/D Sun Rotational Servo (Cont)	e. Servo drives uncontrollably to either end.	(1) Short circuit in amplifier.	(a) Check the output of amplifiers 6A2A3A10, 6A2A3A12, 6A2A3A9, and 6A2A3A8 for a short circuit voltage of ±50 volts dc. (b) Quickly remove the amplifier and make an in-circuit check of the two 2N2405 transistors with an ohmmeter (item 4, table 3-1) on low range. Check these transistors bidriectionally for emitter-collector resistance. If either shows a short circuit, change both. (c) Check CR103 and CR104. If either is shorted, change both. (d) Examine R115 (180 ohms). The in-circuit resistance should be 180 ohms. If below this value it must be replaced.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
41. R/D Sun Rotational Servo (Cont)	f. Servos stop entirely.	(1) Ouput short circuit or high amplitude oscillations.	(a) Check fuses F1, F2 and F3 on 6A2A3A7. (b) If fuse has blown, remove the amplifier and make an in-circuit bidirectional check of transistors Q1 and Q2 with an ohmmeter (item 4, table 3-1) on low range. Check emitter-collector resistance: If one is shorted, replace both. (c) Check the resistance between TP1 on the power amplifier 6A2A3A7 and ground with an ohmmeter. A reading between 600 and 800 ohms is normal. If the resistance is much less check the load circuitry.
	g. Servo drive uncontrollable through 180 degrees and acts normal for the other 180 degrees.	(1) Defective potentiometer.	(a) Remove power amplifier 6A2A3A7 fuses F1, F2 and F3. With a Millivac (item 5, table 3-1) or equivalent, check pin 2 of "B" and "C" section of the follow-up potentiometer while manually rotating the servo.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
41. R/D Sun Rotational Servo (Cont)			The voltage should swing from plus to minus 10 volts dc on each section. Each pin No. 2 should null at a point 180 degrees from each other. If not, check the 1 and 3 terminals for plus or minus 10 volts dc. If pins 1 and 3 show the proper voltage (±10 volts dc) and pin 2 shows only one polarity or none, the potentiometer is defective.
	h. Servo torque is normal on MAN. but has little or no torque on AUTO.	(1) High internal resistance on the wiper arm circuit (No. 2 pin) of the 3-ganged, follow-up potentiometers (A section).	(a) Check potentiometer.
	i. Loss of output.	(1) Poorly seated cards.	(a) Check all cards to be sure they are properly seated. Ultimate operation of amplifiers depends on careful installation.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
41. R/D Sun Rotational Servo (Cont)	j. Lower than normal output voltage.	(1) Maladjustment of gain or defect in feedback potentiometers.	(a) Check output of power amplifier 6A2A3A7 and the feedback potentiometer. Adjust gain or replace defective potentiometer.
	k. Low frequency oscillation of servo.	(1) Follow-up voltage has been lost.	(a) Remove the fuses from the power amplifier and check No. 2 pin of section "B" and "C" of the follow-up potentiometer, while manually rotating servo. A null should be noted 180 degrees between the two potentiometers. Check the presence of plus and minus 10 volts dc on pins 1 and 3 of "B" and "C" sections. If the null is not noted, the potentiometer must be replaced.
	l. High speed operation with little attempt to position.	(1) Loss of tachometer voltage, may have been caused by a short circuit of the tachometer generator, loss of generator voltage, and/or shearing of the generator coupling.	(a) Check the coupler between the motor and generator.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
42. R/D Peripheral Sun Drive	a. Electrical breakdown.	(1) Motor burnout.	(a) Check input voltage.
		(2) Potentiometer burnout, wiper wear and shorting.	(b) Check potentiometer and wipers for shorting and wear. Check circuit for continuity.
43. R/D Sun Periphery Servo	a. No voltage swing.	(1) No input voltage, defective amplifier or shorted diode or transistor.	(a) Check the green TP in the first stage amplifier involved with the servo. A plus or minus 10 volt swing should be noted. If not, refer to the power systems concerning the 10 volt distribution. If swing is noted proceed to next step.
	b. 10 volt swing present but no output variance.	(1) Poorly seated amplifier card or defective amplifier.	(a) Push in each card associated with the servo to be sure it is properly seated. Then check output again.
			(b) If still no response, move test probe to TP1 on summing card. An output swing of plus or minus 10 volts should be observed. This is the output of the first amplifier.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
43. R/D Sun Periphery Servo (Cont)			(c) Follow this procedure through the system and if an amplifier is encountered in which there is no voltage swing it may be assumed that the amplifier itself is defective.
	c. Saturation in either the plus or minus direction (uncontollable fixed voltage of plus or minus 50 volts dc).	(1) Shorted diode, transistor, resistor with low value or amplifier malfunction.	(a) Remove the preamplifier or driver associated with the test point and check the following components: Q104 or Q105 emitter to collector bidirectionally. If Q104 or Q105 is shorted change both.
			(b) R115 must read close to 180 ohms if it is much lower than 180 ohms it must be replaced.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
43. R/D Sun Periphery Servo (Cont)			(c) Check CR103 and CR104 for shorting. If CR103 or CR104 is shorted both must be changed. (d) If condition still exsits and all the preamplifiers are functioning correctly, examine the power amplifier for burned out fuses.
	d. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high voltage of either ±50 volts dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of the two output transistors, Q105 and Q106. If either is found to be defective, change both.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
43. R/D Sun Periphery Servo (Cont)			(b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted, change both.
			(c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.
	e. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) Remove the fuses in the power amplifier 6A2A4A4 and by use of a Millivac or VTVM (item 5 and 4, table 3-1) check the voltage on the No. 2 terminal of the follow-up potentiometer. Manually rotate the servo and look for a null near the center of travel. If no null is found and a unipolarity, slightly attenuated voltage is found, ascertain if a ±10 volts

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
43. R/D Sun Periphery Servo (Cont)			dc appears on terminal No. 1 and No. 3 of the potentiometer. If one of the polarities is found on the potentiometer element, the potentiometer is defective.
	f. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors sustained high amplitude high frequency oscillations.	(a) Check the fuses in the power amplifier 6A4A4A4. If F1 is blown, this may indicate an abnormal heavy load or an accidental short circuit. If F2 and F3 are blown, this may indicate defective power amplifier output transistors. Both these transistors (2N2015) may be checked bidirectionally in circuit with an ohmmeter (item 4, table 3-1) between emitter-collector. If the bidirectional reading is found in either direction, change both transistors.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
43. R/D Sun Periphery Servo (Cont)	g. Servo fails to operate.	(1) Preamplifier with high amplitude a-c signal.	(a) Check the preamplifier outputs for high amplitude a-c signal. The first stage to have this characteristic is at fault. Replace the stage.
	h. Servo has unequal bidirectional velocity.	(1) Defective diode (6A2A4A2CR5).	(a) With the servo system in manual mode observe a ±5.0 volt dc swing at 6A2A4A2TP1. If this swing is not evident the zener diode 6A2A4A2CR5 may be suspected. Remove the summing card 6A2A4A2 and with an ohmmeter (item 4, table 3-1) on high range, bidirectionally check this diode (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
43. R/D Sun Periphery Servo (Cont)	i. Servo drives rapidly through null.	(1) Open circuited generator or sheared tachometer generator/ motor coupler.	(a) Remove the fuses from the power amplifier and rotate the servo manually with the No. 1 end of 6A2A4A2R6 monitored. Use a Millivac or VTVM (item 5 and 4, table 3-1) for this operation. (b) If no voltage is noted, move the VTVM across TB1, pins 9 and 10. TB1 is located on the sun carriage. (c) If no voltage is present, use ohmmeter across the same points (±125 ohms). (d) If the resistance is found and no voltage is found, the trouble is a sheared coupler between the motor and tachometer generator. (e) If no resistance is found the generator is open circuited.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
43. R/D Sun Periphery Servo (Cont)	j. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 or S2 depending on which end the collision occurs. (b) Also check CR1 and CR2 for short circuit.
44. R/D Alpha Servo	a. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high voltage of either ±50 volts dc is the defective stage. Remove this card and, with an ohmmeter (item 4, table 3-1) on low range, check (in-circuit) bidirectionally the emitter-collector resistance of Q105 and Q106 which are the two output transistors (2N-2405). If either is found to be defective, change both.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
44. R/D Alpha Servo (Cont)			(b) Test in the same manner (bidirectionally) the two series diodes adjacent to the output stages. If one is found to be open or shorted, change both.
			(c) Test R115 (in-circuit) for resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.
	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) Remove the fuses in the power amplifier 6A2A4A5 and by use of a Millivac or VTVM (item 5 and 4, table 3-1) check the voltage on the No. 2 terminal of the follow-up potentiometer. Manually rotate the servo and look for a null near the center of travel. If no null is found and a unipolarity, slightly

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
44. R/D Alpha Servo (Cont)			attenuated voltage is found, ascertain if ±10 volts dc appears on terminals No. 1 and No. 3 of the potentiometer. If one of the polarities and only one is found at terminal No. 2 with both polarities found on the potentiometer element, the potentiometer is defective.
	c. Servo fails to operate.	(1) Abnormal load, short circuit, defect output transistors or sustained high amplitude high frequency oscillations.	(a) Check the fuses in the power amplifier 6A2A4A5. If F1 is blown, this may indicate an abnormally heavy load or an accidental short circuit. If F2 and F3 are blown, this may indicate defective power amplifier output transistors. Both these transistors (2N2015) may be checked bidirectionally in circuit with an ohmmeter between emitter-collector. If a bidirectional reading is found in

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
44. R/D Alpha Servo (Cont)			either direction, change both transistors.
	d. Servo fails to operate.	(1) Preamplifier with high amplitude ac signal.	(a) Check the preamplifier outputs for high amplitude ac signal. The first stage to have this characteristic is at fault. Replace the stage.
	e. Servo has unequal bidirectional velocity.	(1) Defective diode (6A2A4A7CR5).	(a) With the servo system in manual mode observe a ±5.0 volt dc swing at 6A2A4A2TP1. If this swing is not evident the zener diode 6A2A4A2CR5 may be suspected.
			(b) Remove the summing card 6A2A4A7 and with an ohmmeter (item 4, table 3-1) on high range, bidirectionally check this diode (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
44. R/D Alpha Servo (Cont)	f. Servo drives rapidly through null.	(1) Open circuited generator or sheared tachometer generator/ motor coupler.	(a) Remove the fuses from the power amplifier and rotate the servo manually with the No. 1 end of 6A2A4A7R6 monitored. Use a Millivac or VTVM (item 5 and 4, table 3-1) for this operation. (b) If no voltage is noted, move the VTVM across TB1, pins 9 and 10. TB1 is located on the sun carriage. (c) If no voltage is present, use ohmmeter across the same points (±125 ohms). (d) If the resistance is found and no voltage is found the trouble is a sheared coupler between the motor and tachometer generator.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
44. R/D Alpha Servo (Cont)			(e) If no resistance is found the generator is open circuited.
	g. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 or S2 depending on which end the collision occurs.
			(b) Also check CR1 and CR2 for short circuit.
45. R/D Beta Servo	a. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high voltage of either ±50 volts dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
45. R/D Beta Servo (Cont)			Q105 and Q106 which are the two output transistors (2N2405). If either is found to be defective, change both. (b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted, change both. (c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.
	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) With a Millivac or VTVM (item 5 and 4, table 3-1) check the voltage on the No. 2 terminal of the follow-up potentiometer. If no voltage at this point, monitor voltage at terminals 1 and 3. If ±10

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
45. R/D Beta Servo (Cont)			vdc is found here, fault is with the potentiometer.
	c. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors or sustained high amplitude high frequency oscillations.	(a) Check the fuses in the power amplifier 6A2A4A12. If F1 is blown, this may indicate an abnormal heavy load (binding) or high frequency and amplitude oscillations causing overheating of the output stages in power amplifier. If F2 and F3 are blown, this may indicate defective power amplfier output transistors. With the power amplifier removed, these transistors (2N2015) may be checked bidirectionally with an ohmmeter between emitter-collector. If a bidirectional reading is found in either direction, a short circuited transistor is the cause.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
45. R/D Beta Servo (Cont)	d. Servo has unequal bidirectional velocity.	(1) Defective diode.	(a) With the servo system in manual mode observe a ±5.0 volt dc swing 6A2A4A9. If this swing is not evident the zener diode 6A2A4A10CR5 may be suspected. (b) Remove the summing card 6A2A4A10 and with an ohmmeter on high range, bidirectionally check this diode (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.
	e. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 or S2 depending on which end the collision occurs. Also check CR1 and CR2 for short circuit.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
46. R/D Camera Carriage Servo	a. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high voltage of either ±50 volts dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of Q105 and Q106 which are the two output transistors (2N2405). If either is found to be defective, change both. (b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted change both. (c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
46. R/D Camera Carriage Servo (Cont)	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) Remove the fuses in the power amplifier 6A2A5A5 and by use of a Milliviac or VTVM (item 5 and 4, table 3-1) check the voltage on the No. 2 terminal of the follow-up potentiometer.
			(b) If no voltage at this point, monitor voltage at terminals 1 and 3. If ±10 vdc is found here, fault is with the potentiometer.
			(c) If none of the supply voltages are present, the fault is in the system.
	c. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors or sustained high amplitude high frequency oscillations.	(a) Check the fuses in the power amplifier 6A2A5A5. If F1 is blown, this may indicate an abnormal heavy load (binding) or high frequency and amplitude oscillations causing

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Rmeedy
46. R/D Camera Carriage Servo (Cont)			overheating of the output stages in the power amplifier. If F2 and F3 are blown, this may indicate defective power amplifier output transistors. With the power amplifier removed, these transistors (2N2015) may be checked bidirectionally in circuit with an ohmmeter between emitter-collector. If a bidirectional reading is found in either direction, change both transistors.
	d. Servo fails to operate.	(1) Open circuited motor or filter.	(a) Check the voltages for their controlled swings up to and including TP1 on the power amplifier. (b) If normal, check for ±30 vdc at terminals A and B of motor filter. (c) Replace the motor or the filter.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
46. R/D Camera Carriage Servo (Cont)	e. Servo has unequal bidirectional velocity.	(1) Defective diode.	(a) With the servo system in manual mode observe a ±5.0 volt dc swing at 6A2A5A8. If this swing is not evident the zener diode 6A2A5A7CR5 may be suspected. (b) Remove the summing card 6A2A5A7 and with an ohmmeter (item 4, table 3-1) on high range, bidirectionally check this diode (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.
	f. Servo drives rapidly through null.	(1) Open circuited generator or sheared tachometer generator/motor coupler.	(a) With a Millivac or VTVM (items 5 and 4, table 3-1) measure the voltage across TB1, pins 9 to 7. TB1 is located on the camera carriage.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
46. R/D Camera Carriage Servo (Cont)			(b) If no voltage is present, use ohmmeter across the same points (±125 ohms).
			(c) If the resistance is found and no voltage is found, the trouble is a sheared coupler between the motor and tachometer generator.
			(d) If no resistance is found the generator is open circuited.
	g. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 or S2 depending on which end the collision occurs.
			(b) Also check CR1 and CR2 for short circuit.
	h. Servo fails to operate completely.	(1) Locked servo due to high frequency and amplitude oscillations.	(a) Remove the fuses from the power amplifier and monitor the outputs. While monitoring the input (6A2A5TP2), reduce the gain potentiometer (R24) located on the summing card until oscillation ceases.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
46. R/D Camera Focus Servo	a. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high voltage of either ±50 volt dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of Q105 and Q106 which are the two output transistors (2N2405). If either is found to be defective, change both. (b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted, change both. (c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
47. R/D Camera Focus Servo (Cont)	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) With a Millivac or VTVM (items 5 and 4, table 3-1) check the voltage on the No. 2 terminal of the follow-up potentiometer.
			(b) If no voltage at this point, monitor voltage at terminals 1 and 3. If ±10 vdc are found here, fault is with the potentiometer.
			(c) If none of the supply voltages are present, the fault is in the system.
	c. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors or sustained high amplitude high frequency oscillations.	(a) Check the fuses in the power amplifier 6A2A5A4. If F1 is blown, this may indicate an abnormal heavy load (binding) or high frequency and amplitude oscillations causing overheating of the output stages in the power amplifier. If F2 and F3 are blown, this may indicate defective power amplifier output transistors. With the power amplifier removed, these transistors (2N2015) may be checked

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
47. R/D Camera Focus Servo (Cont)			bidirectionally in circuit with an ohmmeter between emitter-collector. If a bidirectional reading is found in either direction, change both transistors.
	d. Servo fails to operate.	(1) Open circuited motor or filter.	(a) Check the voltages for their controlled swings up to and including TP1 on the power amplifier. If normal, check for ±30 volts dc at terminals A and B of motor filter. Replace the motor or the filter.
	e. Servo has unequal bidirectional velocity.	(1) Defective diode.	(a) With the servo system in manual mode observe a ±5.0 volt dc swing at 6A2A5A1. If this swing is not evident the zener diode 6A2A5A2CR5 may be suspected.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
47. R/D Camera Focus Servo (Cont)			(b) Remove the summing card 6A2A5A2 and with an ohmmeter (item 4, table 3-1) on high range, bidirectionally check this diode (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.
	f. Servo drives rapildy through null.	(1) Open circuited generator or sheared tachometer generator/motor coupler.	(a) With a Millivac or VTVM (item 5 and 4, table 3-1) measure the voltage across TB1, pins 9 to 7. TB1 is located on the focus servo chassis.
			(b) If no voltage is present, use ohmmeter across the same points (±125 ohms),
			(c) If the resistance is found and no voltage is found, the trouble is a sheared coupler between the motor and tachometer generator.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
47. R/D Camera Focus Servo (Cont)			(d) If no resistance is found the generator is open circuited.
	g. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 and S2 depending on which end the collision occurs. (b) Also check CR1 and CR2 for short circuit.
	h. Servo fails to operate completely.	(1) Locked servo due to high frequency and amplitude oscillations.	(a) Remove the fuses from the power amplifier and monitor the outputs. While monitoring the input (6A2A5A4TP2) reduce gain potentiometer (R24) locat- on the summing card until oscillation ceases.
48. R/D CRT Translation Servo - Window No. 2	a. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high voltage

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
48. R/D CRT Translation Servo - Window No. 2 (Cont)			of either ±50 volts dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of Q105 and Q106 which are the two output transistors (2N2405). If either is found to be defective, change both. (b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted, change both. (c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
48. R/D CRT Translation Servo - Window No. 2 (Cont)	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) With a Millivac or VTVM (item 5 and 4, table 3-1) check the voltage on the No. 2 terminal of the follow-up pot. If no voltage at this point, monitor voltage at terminals 1 and 3. If ±10 volts dc are found here, fault is with the potentiometer.
	c. Servo fails to operate.	(1) Sustained high amplitude high frequency oscillations.	(a) Remove the fuses from the power amplifier 6A2A6A4 and install the oscilloscope probe into 6A2A6A4TP2. Decrease R24 on the summing card until the oscillation disappears.
	d. Servo fails to operate.	(1) Preamplifier with high amplitude a-c signal.	(a) Check the preamplifier outputs for high amplitude a-c signal. The first stage to have this characteristic is at fault. Replace the stage.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
48. R/D CRT Translation Servo - Window No. 2 (Cont)	e. Servo has unequal bidirectional velocity.	(1) Defective diode.	(a) Remove the fuses from the power amplifier and monitor the output, of the preamplifier and driver. If the output is bidirectionally unequal, the zener diode 6A2A6A1CR5 may be suspected. (b) Remove the summing card 6A2A6A2 and with an ohmmeter (item 4, table 3-1) on high range, bidirectionally check this diode (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.
	f. Servo drives rapidly through null.	(1) Loss of tachometer voltage.	(a) Connect the Millivac or VTVM (items 5 and 4, table 3-1) across TB1, pins 16 and 17. TB1 is located on the servo.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
48. R/D CRT Translation Servo - Window No. 2 (Cont)			(b) If no voltage is present, the torque motor may be defective. (c) If the bidirectional voltage is found, check R3 on the summing card for an open circuit.
	g. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 or S2 depending on which end the collision occurs. (b) Also check CR1 and CR2 for short circuit.
	h. Servo fails completely to function.	(1) Open circuit.	(a) Monitor all voltage outputs for proper signal up to and including 6A2A6A4TP1. If normal, check voltage across TB1 and TB3 on the servo. A swing of plus and minus 30 volt should be noted.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
48. R/D CRT Translation Servo - Window No. 2 (Cont)			(b) If no binding is present which would stall the motor, or if no voltage is present between TB1 and TB3, an open circuit is the cause.
	i. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors.	(a) Check the fuses in the power amplifier (6A2A6A4). If F1 is blown, this may indicate an abnormal heavy load or an accidental short circuit. If F2 and/or F3 are blown, this may indicate defective power amplifier output transistors. Both these transistors (2N2015) can be checked bidirectionally in circuit with an ohmmeter between emmitter-collector. If a bidirectional reading is found in either direction, change both transistors.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
49. R/D CRT Translation Servo - Window No. 4	a. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high voltage of either ±50 volts dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of Q105 and Q106 which are the two output transistors (2N2405). If either is found to be defective, change both.
			(b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted, change both.
			(c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
49. R/D CRT Translation Servo - Window No. 4 (Cont)	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) With a Millivac or VTVM (items 5 and 4, table 3-1) check the voltage on the No. 2 terminal of the follow-up pot. If no voltage at this point, monitor voltage at terminals 1 and 3. If ±10 volts dc are found here, fault is with the potentiometer.
	c. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transsistors or sustained high amplitude high frequency oscillations.	(a) Remove the fuses from the power amplifier 6A2A6A5, and install the oscilloscope probe into 6A2A6A5TP2. Decrease R24 on the summing card until the oscillation disappears.
	d. Servo fails to operate.	(1) Preamplifier with high amplitude ac signal.	(a) Check the preamplifier outputs for high amplitude a-c signal. The first stage to have this characteristic is at fault. Replace the stage.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
49. R/D CRT Translation Servo - Window No. 4 (Cont)	e. Servo has unequal bidirectional velocity.	(1) Defective diode.	(a) Remove the fuses from the power amplifier and monitor the outputs of the preamplifier and driver. If the output is bidirectionally unequal, the zener diode 6A2A6A8CR5 may be suspected. (b) Remove the summing card 6A2A6A7 and with an ohmmeter (item 4, table 3-1) on high range, bidirectionally check this diode (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.
	f. Servo drives rapidly through null.	(1) Loss of tachometer voltage.	(a) Connect a Millivac or VTVM (items 5 and 4, tables 3-1) acorss TB1, pins 16 and 17. TB1 is located on the servo.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
49. R/D CRT Translation Servo - Window No. 4 (Cont)			(b) If no voltage is present, the torque motor may be defective. (c) If the bidirectional voltage is found, check R3 on the summing card for an open circuit.
	g. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 or S2 depending on which end the collision occurs. (b) Also check CR1 and CR2 for short circuit.
	h. Servo fails completely to function.	(1) Open circuit.	(a) Monitor all voltage ouptut for proper signal up to and including 6A2A6A5TP1. If normal, check voltage across TB1 and TB3 on the servo. A swing of plus and minus 30 volts dc should be noted.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
49. R/D CRT Translation Servo - Window No. 4 (Cont)			(b) If no binding is present which would stall the motor, or if no voltage is present between TB1 and TB3 an open circuit is the cause.
	i. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors.	(a) Check the fuses in the power amplifer (6A2A6A5). If F1 is blown, this may indicate an abnormal heavy load or an accidental short circuit. If F2 and/or F3 are blown, this may indicate defective power amplifer output transistors. Both these transistors (2N2015) can be checked bidirectionally in circuit with an ohmmeter between emitter-collector. If a bidirectional reading is found in either direction, change both transistors.
50. R/D Raster Size Servo - Window No. 2	a. Servo drives rapildy and uncontrollable to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show high voltage of either plus or minus

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
50. R/D Raster Size Servo - Window No. 2 (Cont)			50 volts dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of Q105 and Q106 which are the two input transistors (2N2405). If either is found to be defective, change both. (b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted, change both. (c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
50. R/D Raster Size Servo - Window No. 2 (Cont)	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) Remove the fuses in the power amplifier 6A2A5A12 and by use of a Millivac or VTVM (items 5 and 4, table 3-1) check the voltages on the follow-up potentiometer. Plus 10 volts dc should be found on pin 3, and minus 10 on pin 1. If either or both are missing, the fault will be found in the supply systems. If both are present and none on pin 2, the potentiometer is defective.
	c. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors or sustained high amplitude high frequency oscillations.	(a) Check the fuses in the power amplifier 6A2A5A12. If F1 is blown, this may indicate an abnormal heavy load or an accidental short circuit. If F2 and F3 are blown, this may indicate defective power amplifier output transistors. Both these transistors (2N2015) may be checked bidirectionally in circuit with an ohmmeter (item 4, table 3-1) between emitter-collector. If a

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
50. R/D Raster Size Servo - Window No. 2 (Cont)			bidirectional reading is found in either direction, change only the defective transistor.
	d. Servo has unequal bidirectional velocity.	(1) Defective diode.	(a) With an ohmmeter (item 4, table 3-1) on high range, bidirectionally check CR5 on 6A2A5A10 (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.
	e. Servo drives rapidly through null.	(1) Open circuited generator or sheared tachometer generator/motor coupler.	(a) With a Millivac or VTVM (items 5 and 4, table 3-1) monitor the voltage across TB1, pins 11 and 12. TB1 is located on the servo chassis.
			(b) If no voltage is present, use ohmmeter across the same points (125 ohms).

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
50. R/D Raster Size Servo - Window No. 2 (Cont)			(c) If the resistance is found and no voltage is found, the trouble is a sheared coupler between the motor and tachometer. generator. (d) If no resistance is found the generator is open circuited.
	f. Servo drives against mechanical stops.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stop collision most often is the result of faulty microswitches S1 and S2 depending on which end the collsion occurs. (b) Also check CR1 and CR2 for short circuit.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
50. R/D Raster Size Servo - Window No. 2 (Cont)	g. Servo fails completely to operate.	(1) Motor or motor filter open circuit.	(a) With a VTVM (item 4, table 3-1) check the voltage at terminals A and B of the motor filter. If the voltage of plus or minus 30 volts dc is present and no mechanical binding is present, the fault is an open circuit in the motor or motor filter.
	h. Servo fails completely to function and is locked in one position.	(1) High frequency and amplitude oscillations.	(a) Remove the fuses from power amplifier 6A2A5A12 and monitor all output voltages. While monitoring 6A2A5A12TP2, reduce the gain with a clockwise rotation of R24 on the summing card. Reduce the gain until oscillations disappear.
51. R/D Raster Size Servo - Window No. 4	a. Servo drives rapidly and uncontrollably to an end limit.	(1) Short circuit in one of the amplifier stages.	(a) Quickly monitor the amplifier test points. The first amplifier in the system to show a high

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
51. R/D Raster Size Servo - Window No. 4 (Cont)			voltage of either plus or minus 50 volts dc is the defective stage. Remove this card and with an ohmmeter (item 4, table 3-1) on low range check (in-circuit) bidirectionally the emitter-collector resistance of Q105 and Q106 which are the two output transistors (2N2405). If either is found to be defective, change both. (b) Test in the same manner (bidirectionally) the two diodes in series which are found adjacent to the output stages. If one is found to be open or shorted, change both. (c) Test R115 (in-circuit) for a resistance of 180 ohms. If an abnormal reading is encountered, change the resistor.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
51. R/D Raster Size Servo - Window No. 4 (Cont)	b. Servo drives uncontrollably to one end or the other.	(1) Loss of voltage on the follow-up potentiometer.	(a) Remove the fuses in the power amplifier 6A2A5A13 and by use of a Millivac or VTVM (items 5 and 4, table 3-1) check the voltages on the follow-up potentiometer. Plus 10 volts dc should be found on pin 3, and minus 10 on pin 1. If either or both are missing, the fault will be found in the supply systems. If both are present and none on pin 2, the pot is defective.
	c. Servo fails to operate.	(1) Abnormal load, short circuit, defective output transistors or sustained high amplitude high frequency oscillations.	(a) Check the fuses in the power amplifier 6A2A5A13. If F1 is blown, this may indicate an abnormal heavy load or an accidental short circuit. If F2 and F3 are blown, this may indicate defective power amplifier output transistors. Both these transistors (2N2015) may be

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
51. R/D Raster Size Servo - Window No. 4 (Cont)	d. Servo has unequal bidirectional velocity.	(1) Defective diode.	(a) With an ohmmeter (item 4, table 3-1) on high range, bidirectionally check CR5 on 6A2A5A15 (in-circuit). A reading of approximately 100K ohms should be noted. If one direction indicates a lower reading, change the diode.
	e. Servo drives rapidly through null.	(1) Open circuited generator or sheared tachometer generator/motor coupler.	(a) With a Millivac or VTVM (items 5 and 4, table 3-1) monitor the voltage across TB1, pins 11 and 12. TB1 is located on the servo chassis. (b) If no voltage is present, use ohmmeter across the same points (125 ohms). (c) If the resistance is found and no voltage is found, the trouble is a sheared coupler between the motor and tachometer generator.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
51. R/D Raster Size Servo - Window No. 4 (Cont)			(d) If no resistance is found the generator is open circuited .
	f. Servo drives against mechanical.	(1) Defective diode, microswitch or mechanical maladjustment.	(a) A mechanical end stops collision most often is the result of faulty microswitches S1 or S2 depending on which end the collision occurs.
			(b) Also check CR1 and CR2 for short circuit.
	g. Servo fails completely to operate.	(1) Motor or motor filter open circuit.	(a) With a VTVM (item 4, table 3-1) check the voltage at terminals A and B of the motor filter. If the voltage of plus or minus 30 volts dc is present, the fault is an open circuit in the motor filter.
	h. Servo fails completely to function and is locked in one position.	(1) High frequency and aplitude oscillations.	(a) Remove the fuses from power amplifier 6A2A5A13 and monitor all output voltages. While monitoring 6A2A5A13TP2, reduce the gain with a clockwise rotation of R24 on the summing card. Reduce the

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
51. R/D Raster Size Servo - Window No. 4 (Cont)			gain until oscillations disappear.
52. R/D -150 Volt Power Supply 7A1A4, 7A2A5	a. No output or large error in output.	(1) Defective component.	(a) Place power switch in OFF position. WARNING Discharge all filter capacitors in power supply. (b) Perform resistance measurements of the following components: Pins 1 and 2 of transformer T1 (0 ohms) and between pins 7 and 8 of transformer T1 (90 ohms). Forward resistance of CR5 (less than 50 ohms). (c) Replace components that are found to be defective.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
52. R/D -150 Volt Power Supply 7A1A4, 7A2A5 (Cont)	b. Output out of tolerance.	(1) Defective component.	(a) Place power switch in "ON" position. (b) Perform voltage measurements across filter capacitors. Approximately 350 volts dc across C47 and approximately 300 volts across capacitors C48 and C42. (c) Replace components that are found to be defective. (d) If still inoperative, check V12 and loading on -150 volt supply.
53. R/D Voltage Regulator 8A2A9	a. No meter indication of output voltage.	(1) Defective input fuses or input line and connections.	(a) If meter indicates no output voltage, check the input line, input fuses and input connections. If meter indicates approximately line voltage, proceed to 53b.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
53. R/D Voltage Regulator 8A2A9 (Cont)	b. Malfunctioning pilot light.	(1) Defective or blown control fuse.	(a) Check the control unit pilot light. (b) If it does not light, the control fuse is probably blown. (c) If it does light, the control unit is energized.
	c. Poor voltage regulation.	(1) Defective control unit.	(a) If the control circuit does not appear to be operating satisfactorily, throw the circuit breaker to the "off" poisition. (b) If further test indicate that the fault is in the control unit, it is disirable to obtain an exchange control unit.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
53. R/D Voltage Regulator 8A2A9 (Cont)			(c) To make certain that the power section is functioning properly, after the control unit is removed, remove the leads from the motor board and apply 115 volts between the common and red and then between the common and black leads. (d) It should be possible to cause the powerstat to rotate through its entire range.
54. R/D GPL +300 Volt Power Supply 8A2A4 and 8A2A5	a. Blower motor not operating and red pilot light is not lit.	(1) Defective wiring or no input power.	(a) Check primary power input wiring. (b) Remove defective part and replace.
	b. Primary power being supplied but no output voltage.	(1) Output fuse.	(a) Check output fuse (0.5 amp). (b) Remove and replace defective part.
	c. Primary circuit functioning but no output power.	(1) Defective tube.	(a) Check for unlit tubes. (b) Remove and replace part.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
54. R/D GPL +300 Volt Power Supply 8A2A4 and 8A2A5 (Cont)	d. No output voltage.	(1) Defective wiring or fuse.	(a) Set switch S2 to VREG position and plug multimeter (item 4, table 3-1) (set for dc) into meter jack J2 (multimeter set to 0-10V scale, multiply reading by 100 to obtain actual output). (b) If normal indication (300 volts), check 15 amp fuse on front panel and distribution wiring. (c) If no indication go to 54e. (d) If reading high or low go to 54e.
	e. No indication of voltage from meter jack J2 and filaments are not lit.	(1) Defective transformer or no primary power.	(a) Check primary power and transformer T2. (b) Repair or replace defective part.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy'
54. R/D GPL +300 Volt Power Supply 8A2A4 and 8A2A5 (Cont)	f. No indication of voltage from meter jack J2 and filaments are lit.	(1) Defective relay K1.	(a) Connect multimeter (item 4, table 3-1) to pins 1 and 3 of T1. (b) If indication is abnormal check relay K1. (c) If indication normal - go to 54g (115 volt ac).
	g. No indication of voltage from meter jack J2 and filaments are lit.	(1) V5 or L1 defective.	(a) Connect multimeter (item 4, table 3-1) to pins 1 of L1 and C2. (b) If indication normal check V5 and L1 (10 volt ac). (c) If indication abnormal check T1 and CR1 through CR8. Repair or replace defective part.
	h. Reading from meter jack J2 is too high or too low.	(1) Defective tubes.	(a) Remove V3 and Set S2 to "IT" position. Plug multimeter (item 4, table 3-1) into meter jack J2.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
54. R/D GPL +300 Volt Power Supply 8A2A4 and 8A2A5 (Cont)			(b) If indication is normal (400 ma) take voltage and resistance readings of V3 and V4. (c) If indication is abnormal, check V1 and V2 with multimeter and switch S2. (d) Replace or repair defective part.
55. R/D +900 Volt Power Supply 7A1A4 and 7A2A5	a. Loss of output voltage.	(1) Defective diode.	WARNING Be sure power switch is in "OFF" position before lead hook up. (a) Set multimeter (item 4, table 3-1) scale to cover 1000 volts. Place leads across V12 and turn power switch to "ON". (b) Meter should read between 850 and 950 volts. If indication is normal, check wiring in camera control.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
55. R/D +900 Volt Power Supply 7A1A4 and 7A2A5 (Cont)			(c) If indication is abnormal replace V12.
			(d) If still abnormal proceed to 55(d).
	b. Loss of output voltage.	(1) Defective resistors.	(a) Place power switch at system control in "OFF" position. WARNING Discharge all filter capacitors of power supply.
			(b) Connect multimeter (item 4, table 3-1) across resistors R86 and R87.
			(c) If indication is normal, replace R86 and R87.
			(d) If indication is abnormal, proceed to 55(c). WARNING High voltage.
			(e) Place power switch in "ON" position.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
55. R/D +900 Volt Power Supply 7A1A4 and 7A2A5 (Cont)	c. Loss of output voltage.	(1) Defective component.	(a) Perform resistance measurement of power supply components. The front resistance of CR13, CR14, and CR15 is approximately 400K ohms. The reverse resistance of CR13, CR14, and CR15 is infinite.
	d. Loss of output voltage.	(1) Defective component.	(a) Perform resistance measurements across C45, C46,and C49. Remove wires to make measurements (resistance should be infinite). Measure across R81 (20K ±5%).
	e. Loss of output voltage.	(1) Defective transformer.	(a) Measure resistance across primary (A1) and secondary (A2). (A1 = 0 ohms) (A2 = 90 ohms) Replace defective transformer if indications are not normal.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
56. Trygon Power Supplies-Servos	a. Loss of d-c servo power.	(1) Excessive line vlotage transient. (If one supply ceases to operate, all supplies are automaticall stopped due to the sequential relay system).	(a) Turn the line voltage off and then back on with the HC POWER ON switch in unit 6. After a delay period of approximately 11 seconds, the system should operate normally and all servos should return to their position at time of power loss.
57. Trygon Power Supply 437178	a. Pilot light not working.	(1) Defective wiring, lamp resistor or switch.	(a) Check lamp. (b) Check fuse (F1). (c) Check lamp series resistor for open. (d) Check a-c "ON" switch for defective contacts.
	b. No output voltage.	(1) Defective diode, transistor, capacitor, potentiometer, or thermal switch.	(a) Make point resistance check of all components in the output circuit.
	c. F1 blows.	(1) Defective T1.	(a) Check windings for shorts. (b) Check winding for grounds.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
57. Trygon Power Supply 437178 (Cont)	d. F3 blows.	(1) Defective diode, transistor or capacitor.	(a) Make point to point resistance check of all components in the circuit.
58. Trygon Power Supply 437684	a. No output.	(1) Circuit breaker CB1.	(a) Check circuit breaker CB1 for continuity.
		(2) Thermal switch S1.	(a) Check thermal switch S1 for continuity.
		(3) Transformer T1.	(a) Check transformer T1 for shorted or open windings.
		(4) Capacitors C1, C2, C3, C11.	(a) Check C1, C2, and C3 for short. Check C11 for short.
		(5) Transistors Q26, Q34, Q35.	(a) Check Q26 for collector to emitter short. Check Q43 for collector to emitter and collector to base shorts. Check Q35 for collector to emitter and collector to base short.
		(6) Resistors R1 through R20 and R130 through R150.	(a) Check continuity of resistors R1 through R20. Check continuity of resistors R130 through R150.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
58. Trygon Power Supply 437684 (Cont)			(b) Reset CB1, repair or replace defective part.
	b. No output (amp meter indicates full load current).	(1) CR12	(a) Check CR12 for short.
		(2) C4, C5, C6	(b) Check C4, C5, C6 for short.
	c. No output (circuit breaker trips when set).	(1) C1, C2, C3	(a) Check C1, C2, C3 for short.
			(b) Check CR1 through CR6 for shorts.
	d. Nonregulated output.	(1) Q1 through Q25, Q28.	(a) Check Q1 through Q25 and Q28 for collector to emitter or collector to base shorts.
	e. Current adjust control inoperative.	(1) R76	(a) Check R76 potentiometer for open winding.
		(2) CR35	(b) Check CR35 for open circuit. Repair or replace defective part.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
59. Trygon Power Supply 437180	a. No output (no indication on meters DS1 not lit. Fan B1 not operating).	(1) Fuse F1, switch S1.	(a) Check continuity of fuse. (b) Remove power from terminals 1 and 3 of terminal boards. (c) Turn S1 on. (d) With ohmmeter (item 4, table 3-1) on RX1 scale, measure 0 ohms between TB1-1 and fuse F1, and 0 ohms between TB1-3 and T1-14.
	b. No output (no indication on meters, DS1 lit, fan B1 operating, DS2 not lit).	(1) Open winding on primary of T1, switch S-2.	(a) Check T1 summary for opens. Replace T1 if open. (b) Place S1 in "OFF" position. (c) Place S2 in "ON" position. (d) With ohmmeter (item 4, table 3-1) on RX1 scale, measure 0 ohms across contacts of S2. Replace S2 if inoperative.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
59. Trygon Power Supply 437180 (Cont)	c. No ouptut (F1 keeps blowing).	(1) Shorted winding on T1. Shorted transistor, capacitor or diode.	(a) Make resistance check of T1 and all transistors, diodes and capacitors. Replace defective component.
	d. No output (DS1 lit, fan B1 operates, when S2 is turned on fuse F1 blows.	(1) Short in bridging circuit.	(a) Make point to point resistance check of diodes CR1, CR2, CR3, CR4, C1, C2, C3, C4, C10.
			(b) Check switch S3 for grounds. Replace defective part.
	e. No output adjustment.	(1) Potentiometer; dirty wiper partial short or open.	(a) Resistance check R40 and R34. Replace defective part.
60. Trygon Power Supply 437681	a. No output (DS1 not lit, blower B1 does not operate, meters do not indicate).	(1) Fuse F1.	(a) Check fuse continuity. Replace F1 if open.
		(2) Switch S1.	(b) Remove power connections from TB1 terminals 1 and 3.
			(c) If switch closes, check all components in circuit for overload or short. Replace defective component.

Table 3-7. Trouble Analysis (Cont)

Unit	Trouble	Probable Cause	Procedure/Remedy
60. Trygon Power Supply 437681 (Cont)	b. No output (DS1 lit, blower B1 operates).	(1) T1 open.	(a) Check continuity of T1. Repalce T1 if open.
		(2) S2 open.	(b) Check continuity of S2. If S2 checks open, allow time for unit to cool and recheck switch.
			(c) If switch closes, check all components in circuit for overload or short. Replace defective component.
	c. Voltage adjustment.	(1) Potentiometer R37 or R38 open shorted or dirty.	(a) Check continuity of R37 and R38. Replace defective component.

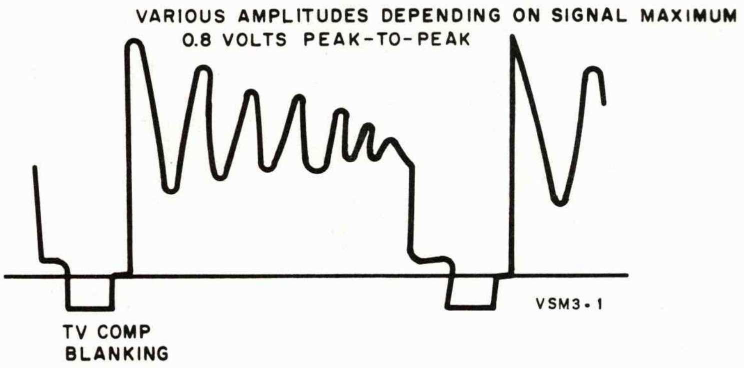


Figure 3-1. Video Signal Waveforms TP2 through TP6

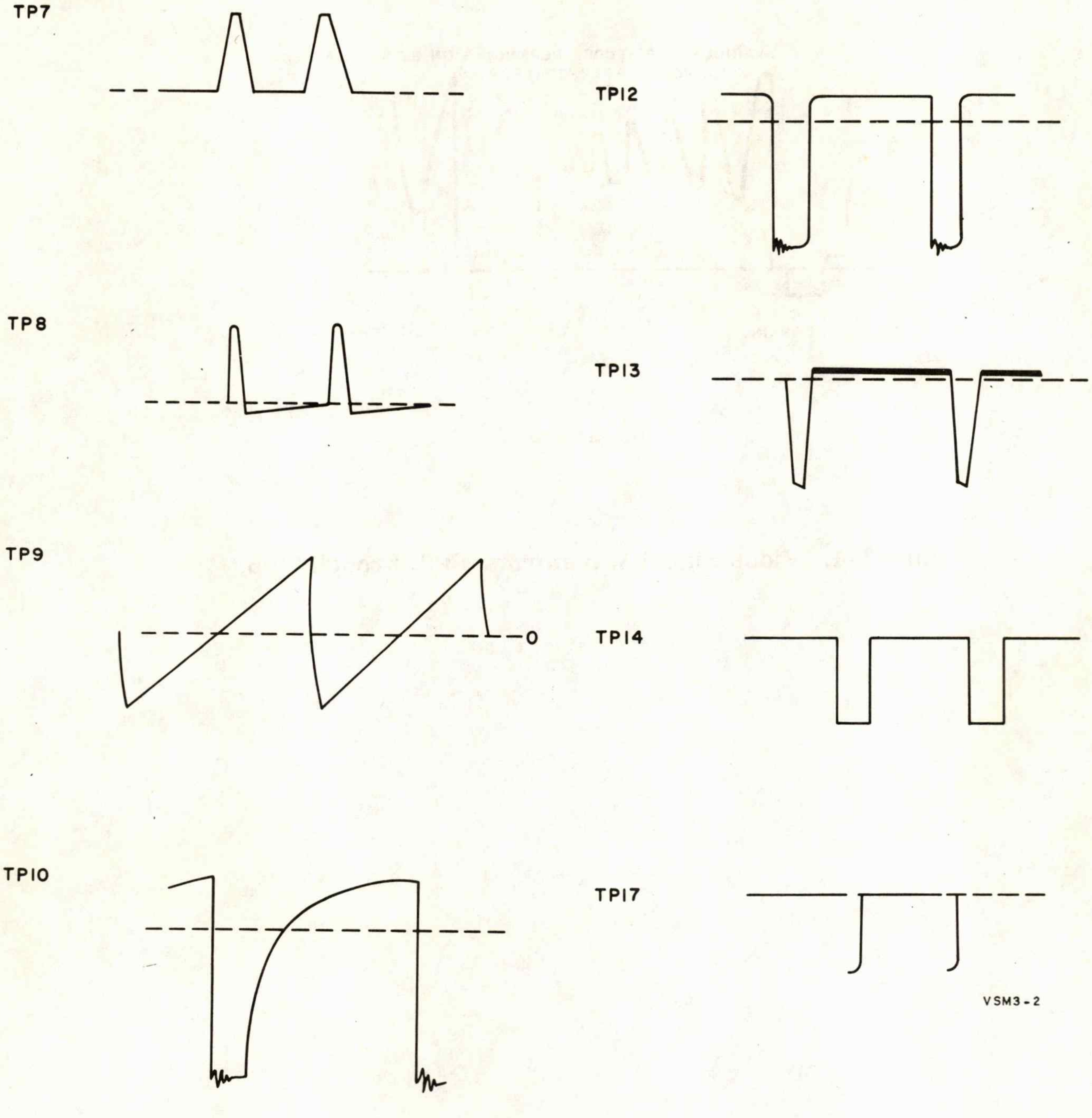
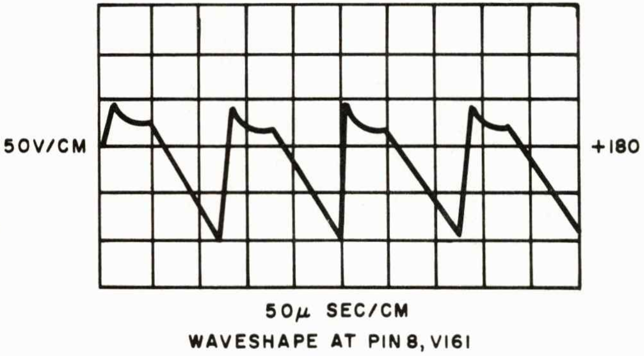


Figure 3-2. Video Signal Waveforms TP7 through TP17



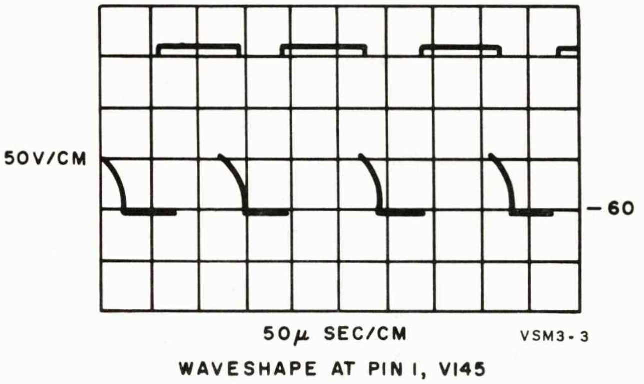


Figure 3-3. Video Signal Waveforms - Sweep Generator

SECTION IV

REMOVAL AND INSTALLATION

4-1. GENERAL.

4-2. Removal and installation of the assemblies installed in the visual system is, for the most part, straightforward and no discussion of the methods is necessary. Where unusual procedures, techniques, or tools are employed, specific step by step information is given, thereby enabling maintenance personnel to remove or install an assembly or subassembly in a minimum amount of time.

4-3. In most cases, installation is the reverse of removal; therefore, no discussion is included on the installation. Where, in some instances, additional steps are needed for the installation of an assembly, these steps are included at the end of the removal section with the proper notation as to the sequence to be taken.

4-4. After an assembly or component is installed, a thorough check should be made to insure that the alignment is correct. For alignment, calibration, and adjustment procedures covering these specific areas, refer to Section VI.

4-5. TELESCOPE AND SEXTANT.

4-6. The telescope and sextant equipment, for the most part, should require very little maintenance. The optical assemblies of the telescope and sextant are housed in dust tight enclosures. Access panels are provided on the enclosures at various locations for ease of accessibility. Whenever the covers or panels are removed, the optical elements of the equipment should be protected against dust or other foreign matter. Removal and installation of the assemblies are divided into three main areas: telescope, sextant, and telescope/sextant electronics cabinet. Procedures relating to each unit are provided under the appropriate heading.

4-7. TELESCOPE.

4-8. The removal of the MEP, celestial sphere, or the associated C/S illuminator and occulting assembly, as well as any of the fixed optical components housed within the telescope, requires the removal of access covers on the bottom or upper front panels; and in some instances, the removal of complete panel sections.

CAUTION

> The observance of the most rigid precautions against the entrance of dust, or other contaminants, into the telescope during removal, repair, or maintenance cannot be overstressed. Precautions for the removal of an assembly from the telescope (except the eyepiece assembly from the mounting plate inside the command module) must include the immediate availability of barrier material and pressure sensitive tape to be applied as soon as possible to any opening to the optical paths. Furthermore, prior to the replacement of access covers or cover panels, following the installation of interior assemblies MEP, celestial sphere, and C/S illuminator and occulting unit, all exposed mirror and lens surfaces must be carefully cleaned by the use of a camel-hair brush or lens cleaning tissue, as required.

The removal of a fixed optical component may be considered as a remote possibility since, in a thermally controlled environment, breakage or other damage of the glass elements is unlikely to occur.

4-9. EYEPIECE REMOVAL. The removal and installation of the telescope's eyepiece and connected prism housing assemblies are operational procedures performed by the astronaut at specified times during a simulated mission. The enlarged and exploded view of the mounting panel and the above two items on figure 1-3 illustrates the method for eyepiece removal and installation. A socket head screw key is used on the two captive 1/4-20 inch socket head cap screws that attach the prism housing flange to the mounting panel. As indicated in the CAUTION above, a window in the panel assembly maintains a seal when the eyepiece is removed.

4-10. RETICLE, OCCULTING, AND LENS ASSEMBLY. (See figure 4-1.) Removal of the reticle, occulting, and lens assembly as a unit, is a prerequisite for the removal of the rotating reticle assembly, or the command module occulting assembly. This assembly also contains a lens cell which, under normal circumstances, should not have to be removed from the casting; but whose external glass surfaces must be adequately protected from dirt or damage, whenever the casting is out of the telescope. The removal procedures for the reticle, occulting, and lens assembly are as follows:

a. Disconnect interconnecting cables W542 and W543 from connectors 13J1 and 13J2, and remove wire bundle clamps wherever the wire bundles are secured to the supporting members. Disconnect sunshafting lamp leads at contacts 7 and 8 on terminal board 13TB2 located on the front of the assembly cover plate.

b. Remove the contracting ring securing the rubber bellows to the flange of the lens and mirror housing adapter and pull the rubber bellows off the flange.

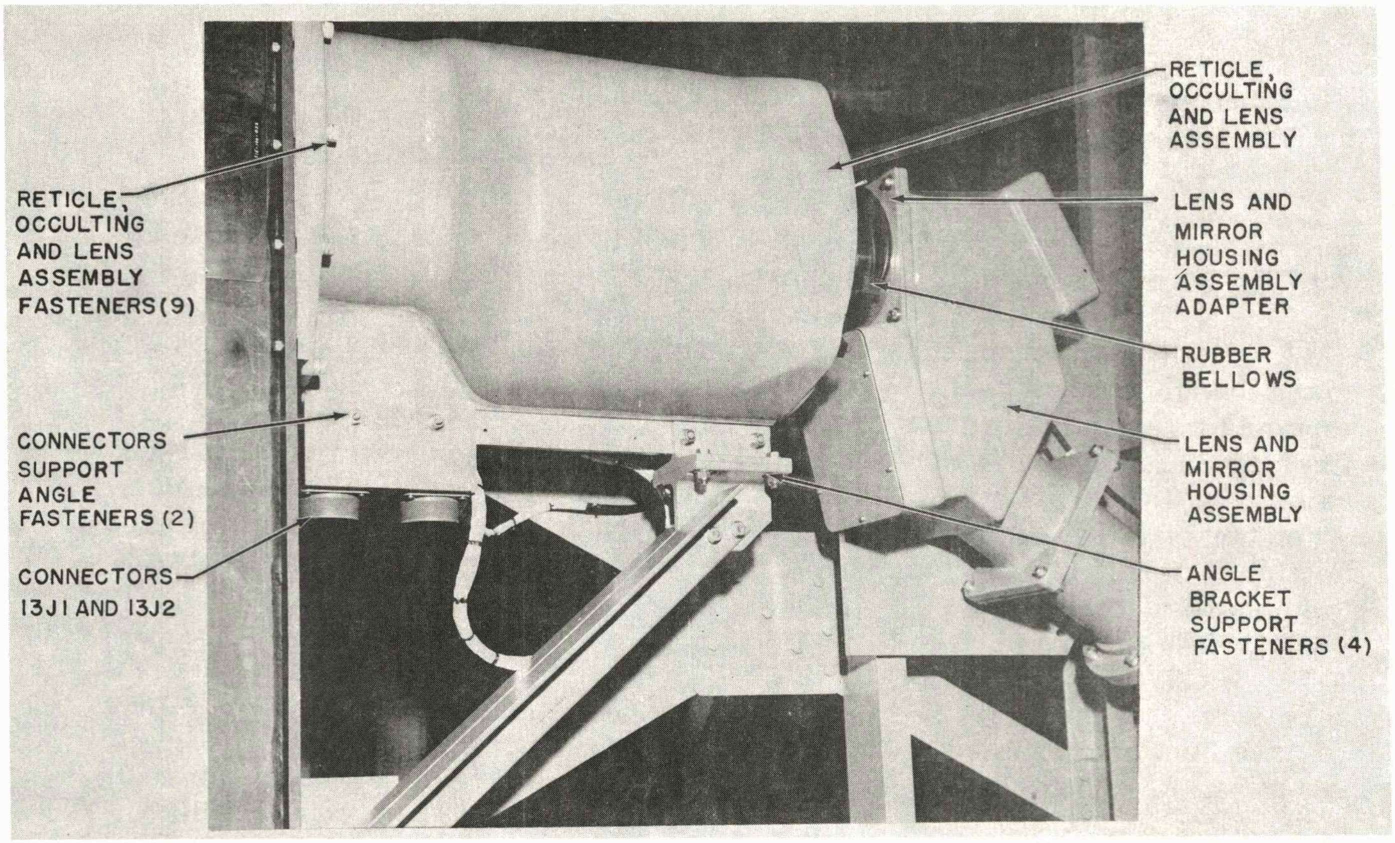


Figure 4-1. Reticle, Occulting and Lens Assembly Mounting

c. Remove the lens and mirror housing adapter from the lens and mirror housing assembly. Immediately tape protective barrier material over the opening of the first cell assembly in the lens and mirror housing assembly.

d. Remove the nine 3/8 inch cap screws attaching the assembly to the face of the optical bridge, and remove the four 5/16 inch bolts and nuts connecting the angular support members to the ribs on the bottom and side of the casting; the side rib bracket supports are shown in figure 1-5.

CAUTION

Extreme care must be exercised to maintain manual control of the assembly following removal of the fasteners.

e. Slide the assembly straight forward approximately 1/2 inch or sufficiently enough to clear the dowel pins in the face of the optical bridge. Tape barrier material over the four inch diameter hole in the optical bridge as soon as possible.

f. Tape barrier material over the entire end of the casting adjacent to the electrical connectors 13J1 and 13J2 as protection for the cell assembly.

g. Carefully remove the reticle, occulting, and lens assembly from the telescope, and place it on a clean work bench in the vertical position, with the rotating reticle mounting plate uppermost.

4-11. Following reassembly of the reticle, occulting, and lens assembly, after maintenance or repair, the installation of the assembly in the telescope is performed by reversing procedures a. through g. To keep exposure time of the interior to contamination or damage at a minimum, do not remove the protective barrier until just prior to installation of a replacement or repaired assembly. When the installation is completed, perform the functional test described in Section II of this manual to assure optical alignment and proper functioning of the operable components.

4-12. ROTATING RETICLE ASSEMBLY. (See figure 4-2.) The rotating reticle assembly is removed from the reticle, occulting, and cell assembly for either replacement of reticle edge lighting lamps, or replacement of the entire rotating reticle assembly (see Section V). If the reason for removal is the replacement of the lamps, the performance of steps a., b., and c., only are required; if the entire reticle assembly is to be replaced, perform the additional steps described in paragraph 4-13.

CAUTION

> The maintenance of absolute cleanliness of the exposed surface of the engraved reticle is extremely important, whenever the rotating reticle assembly is removed from the reticle, occulting, and lens assembly. For this reason, a quantity of lens cleaning tissue must be readily available to cover the glass surface the instant the rotating reticle is removed from the casting, as described in the procedural steps listed below. The protective material must remain in place all the while the rotating reticle is out of the reticle, occulting and lens assembly.

a. Remove the reticle, occulting, and cell assembly as described in paragraph 4-10.

CAUTION

> The following procedure must be performed slowly and carefully, keeping the reticle mounting plate as nearly horizontal as possible during the removal, to avoid possible damage to the occulting blades mechanisms.

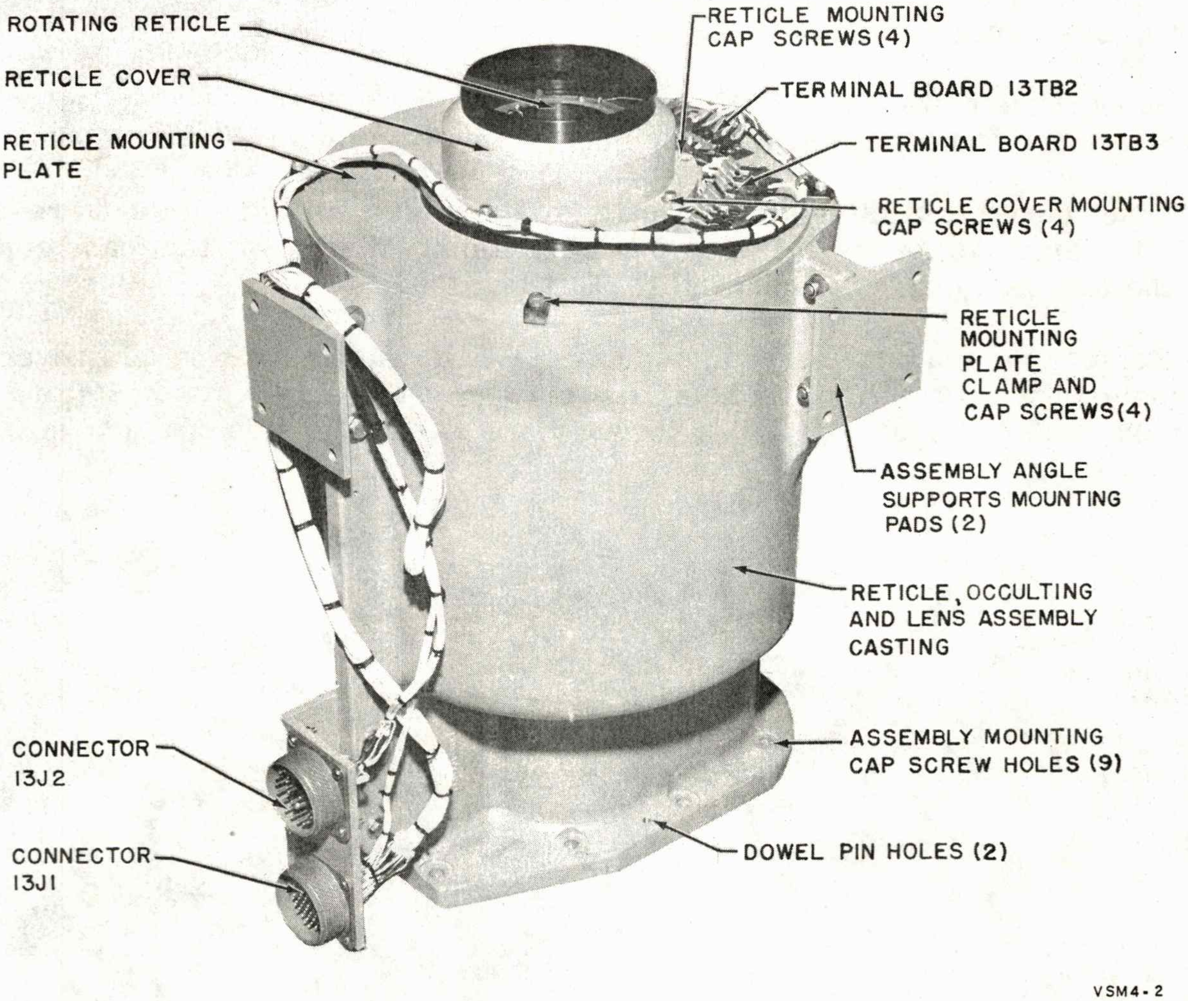


Figure 4-2. Reticle, Occulting and Lens Assembly

b. Remove the four clamps that secure the cover plate to the casting; lift the cover plate, with reticle assembly attached, straight up and out of the casting. See CAUTION under paragraph 4-12 above.

c. Unless the C/M occulting assembly is to be removed immediately, tape barrier material over the opening of the casting after removal of the cover plate, to protect the occulting unit and lens cell from contamination.

CAUTION

If the rotating reticle removal is for the purpose of edge lighting lamp replacement, no further disassembly is necessary. The lamps are accessible by merely turning the cover plate over. See Section V for the lamp replacement instructions, and figure 5-1 for illustration.

4-13. To remove the rotation reticle assembly from the mounting plate, proceed as follows (see figure 4-3):

a. Support the plate horizontally on the work bench on blocking of sufficient height to keep the end of the reticle assembly from contact with the bench surface.

b. Disconnect all of the electrical leads to the motor of the reticle and resolver from terminal boards 13TB2 and 13TB3. Do not disconnect the leads connecting the terminal boards to connectors 13J1 and 13J2.

c. Remove the four cap screws, and carefully lift the rotating reticle cover off the assembly. As the cover is being removed, pull the torque motor stator leads, marked 13TB3-2 and 13TB3-3, throught the hole in the side of the cover.

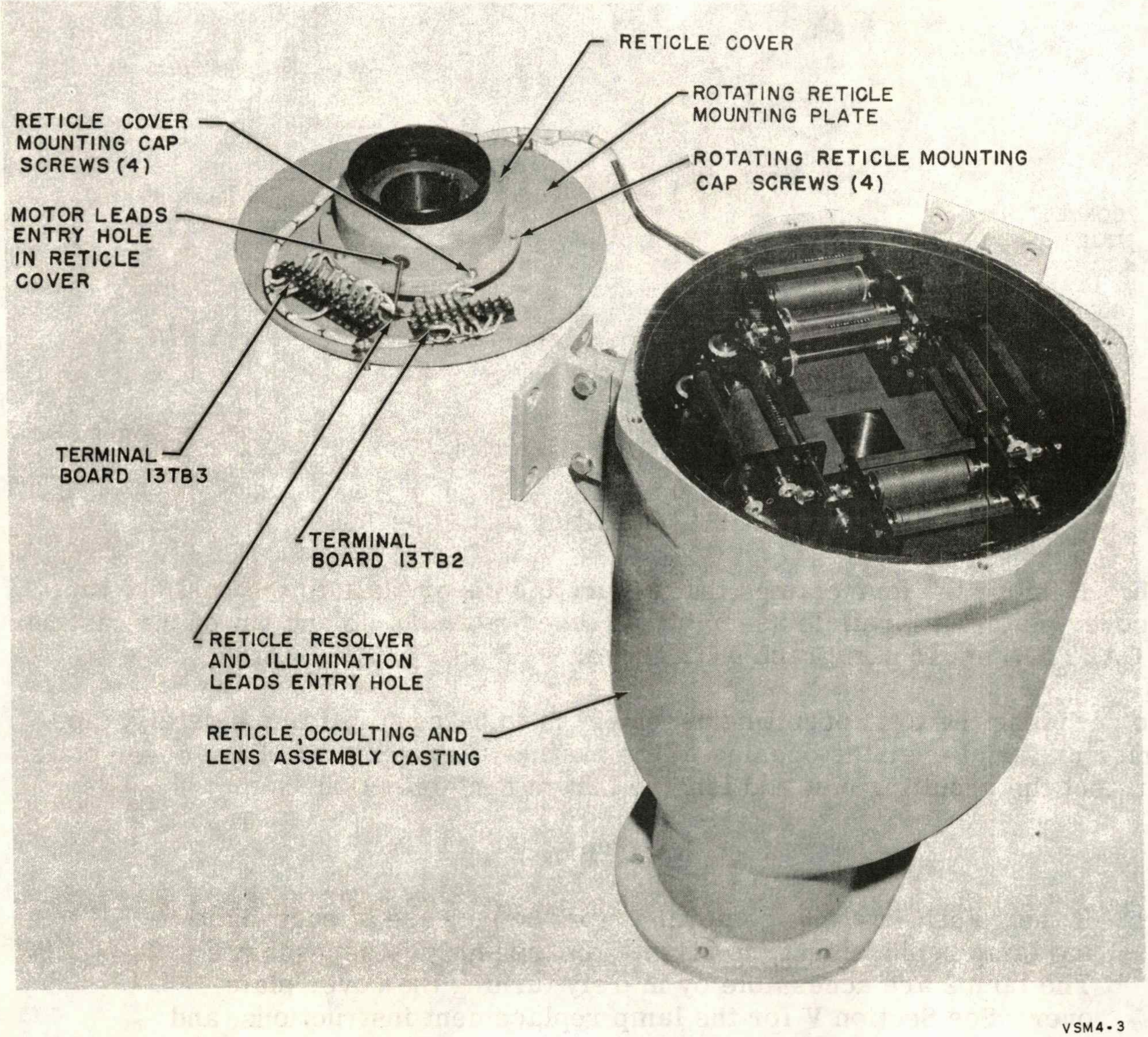


Figure 4-3. Rotating Reticle Removed from Reticle, Occulting and Lens Assembly

d. Pull the resolver and reticle illumination leads back through the hole in the reticle mounting plate; the leads must be passed throught the grommet, one at a time.

e. Remove the four cap screws, and lift the reticle assembly out of the hole in the mounting plate.

Reassemble the rotating reticle on the mounting plate by reversing the above procedures. As in the case of removal, the resolver and illumination electrical leads must be passed through the hole in the plate singly. Before reassembling the rotating reticle to the reticle, occulting, and lens assembly, remove the protective lens tissue, previously placed over the engraved reticle disc and carefully brush the glass surface with a camel-hair brush to remove any minute dust particles.

NOTE

The reticle surface must be as clean as possible to achieve the best performance of the telescope.

4-14. C/M OCCULTING ASSEMBLY. (See figure 4-4.) In order to perform any maintenance or repair to the C/M occulting assembly, the unit must be removed from the reticle occulting, and lens assembly. Removal procedures are as follows:

a. Remove the reticle occulting, and lens assembly from the telescope, as instructed in paragraph 4-10.

b. Refer to the CAUTION in paragraph 4-12; and then, perform procedures a. and b. of paragraph 4-13 to remove the rotating reticle assembly.

NOTE

Prepare for the following procedure by placing a small disc of double sided adhesive tape (3M Scotch Brand No. 400-2DCC-C9131, or equivalent) on the end of a socket head screw key that will fit a No. 10 size socket head cap screw. The key must be approximately seven inches long.

c. Using the socket head screw key, prepared as above, remove the four No. 10-32 x 5/8 inch socket head screws that secure the occulting unit's lower plate to the mounting band in the casting.

d. Grasp two diametrically opposite hexagonal spacing bars (between the occulting blade reel bearing plates), and while the bundle of electrical leads is pushed through the hole, carefully lift the occulting unit out of the casting. Care must be exercised not to put tension on the leads as the occulting unit is removed.

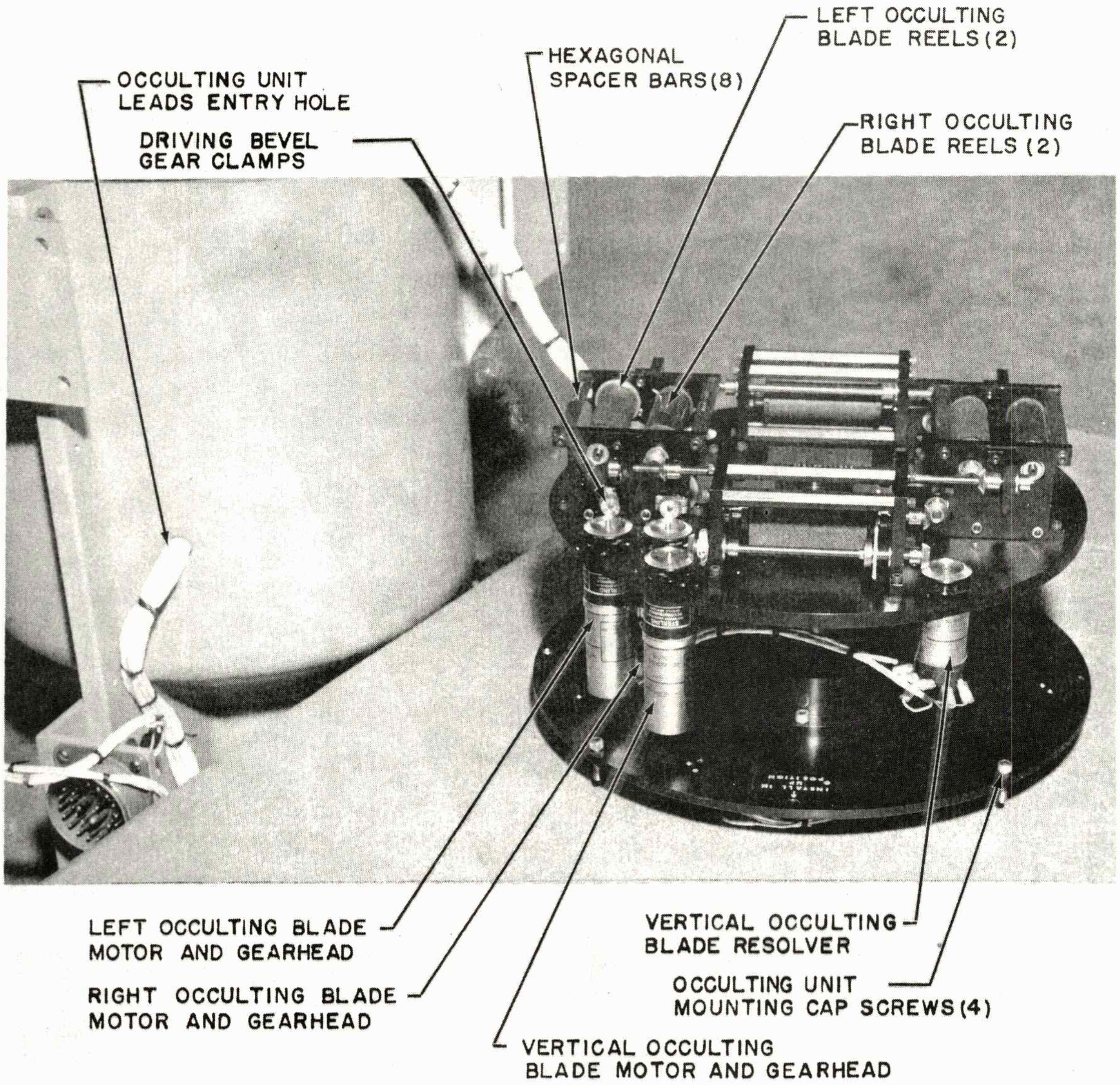


Figure 4-4. C/M Occulting Assembly Removed from Casting

e. When the occulting unit is out of the casting, immediately tape barrier material over the exposed surface of the lens cell; also, cover the 1-1/4 inch hole in the cell mounting plate.

f. Place blocking near the casting to support the occulting unit. The blocking should be located so as not to damage the wiring or terminal boards on the under surface of the mounting plate. Pull out the remaining slack in the electrical leads to the terminal boards of the occulting unit. Sufficient slack is provided to permit performance of maintenance and repair to the occulting unit.

4-15. Reassembly of the C/M occulting assembly in the reticle, occulting, and cell assembly casting, following maintenance or repair, is accomplished by reversing the above procedures.

CAUTION

> To prevent the interference of electrical leads with the optical line-of-sight, all of the slack, referred to above, must be pulled back through the hole in the side of the casting. This must be accomplished before reconnecting connector 13J1, following installation of the reticle, occulting, and lens assembly on the telescope.

4-16. MISSION EFFECTS PROJECTOR (MEP). (See figure 1-5.) The removal of the MEP requires the entrance of a technician into the telescope through an access opening in the cover panels. Access openings are provided through the bottom panel and through the topmost panel on the front, or command module, side of the telescope. Removal of MEP securing bolts is most easily accomplished by entrance through the pentagonal access opening on the front of the telescope.

CAUTION

> The CAUTION, refer to paragraph 4-7, regarding the immediate application of barrier material to prevent the entrance of dust or other foreign material into the telescope obviously cannot be observed completely during the removal and replacement of either of the scene generating equipments. However, it is necessary to again emphasize the necessity to exercise the utmost precautions against the entry of dust into the instrument, during maintenance or repair procedures.

4-17. The MEP is secured to the telescope by twenty 1/2-13 inch socket head cap screws that are screwed into four adjustable mounting brackets, which, in turn, are attached to a rectangular opening in the top of the frame weldment. The four mounting brackets, one on each side and end of the retangular opening, should not be moved, because they are positioned during the initial and assembly alignment of the telescope to facilitate installation of a replacement MEP. The brackets ensure correct positioning of the replacement MEP with reference to the landmark line of sight. Removal of the MEP is accomplished as follows:

a. Refer to appropriate paragraphs for instructions regarding electrical disconnection and other instructions preparatory to MEP removal.

b. Remove the access opening cover in the upper front panel of the telescope, referred to in paragraph 4-16.

c. Remove the access cover from the underside panel of the telescope, and attach flood-lighting lamps to the interior frame members so as to adequately illuminate the interior of the telescope.

CAUTION

> In order to avoid damage to the celestial sphere or any of the optical components in the telescope, prepare a light-weight, easily handled frame covered with plastic film, or other material that will not interfere with the interior illumination. Place it below the MEP in such a position as to catch any cap screw, washer, or tool that might accidentally be dropped during the removal of the MEP fasteners.

d. The technician, after carefully inspecting the interior of the telescope to predetermine his footing, should enter the telescope through the upper front access opening.

e. Remove the twenty 1/2 inch socket head cap screws, lockwashers and flat washers that secure the flange of the MEP to the mounting brackets. There are seven cap screws along each side and three at each end.

f. The technician must emerge from the telescope as quickly as possible after removal of the fasteners, and the access covers must be replaced using the minimum number of fasteners to adequately hold them in place.

g. Refer to the appropriate instructions regarding placement of lifting slings. Using overhead hoisting gear of adequate capacity (the MEP weighs approximately 650 pounds), lift the assembly straight up and out of the telescope frame.

h. When the MEP has been removed, immediately cover the rectangular opening with barrier material which must remain in place until just prior to the installation of a replacement or repaired MEP.

4-18. Essentially, installation of the MEP is accomplished by reversing the removal procedures, but with the following exception the access covers are removed first; the interior illumination lamps are installed; and the technician enters the telescope and positions himself so as to guide the MEP into place on the mounting brackets.

4-19. EARTH/MOON AND LEM OCCULTATION ASSEMBLIES. Removal of the occultation assemblies is necessary whenever a tape is replaced. In order to accomplish the removal, the ring gear and carriage must be at the X and Y axis origin and the tape fully unwound. Removal of any of the occulting units is similar and can be accomplished by the following procedure.

a. Center the ring gear and carriage by turning the appropriate X and Y axis toggle switches to the "MAN" position.

b. Rotate the associated command potentiometers as required while observing the black shadow of the occulter against the C/S. (In the R and D windows both occulters should be unwound.)

c. Unwind the tape from the windup pin by rotating the associated AUTO-MAN toggle switch (Test Panel I-A19) to the "MAN" position.

d. Turn the Z-axis command potentiometer counter clockwise until the tape is completely unwound. (Limit switches will automatically open when unwound condition is reached.)

e. Return all toggle switches to the "AUTO" position and shut down the power.

f. Remove the bottom and back covers.

g. Remove the six bolts holding the occulting assembly.

h. Disconnect the cable and remove the assembly.

4-20. Occultation Tape Replacement. Tape replacement should be accomplished in the event of tape breakage rather than splicing. Replacement procedures are identical for both the Earth/Moon and LEM occulting assemblies. Remove the tape by following the listed procedures.

a. Remove the occulting assembly. (Refer to paragraph 4-19.)

b. Remove the upper glass plate of the assembly by removing the four washers and screws.

c. Check the windup pin for damage.

d. Lift the broken tape from the center windup pin.

e. Remove the reel tape from the reel by removing the center screw and lockwasher holding the reel cover.

f. Secure the end of the new tape from the new tape reel on the tape windup pin by taking two snug turns around the pin.

g. Pull the tape finger tight and place the axle of the new reel in the socket.

h. Replace the reel cover with the screw and replace the upper glass plate.

4-21. RENDEZVOUS AND DOCKING WINDOW STRUCTURES. When removing any of the major assemblies of the rendezvous and docking window structures, either for dismantling, or for replacement of an optical element, certain procedures should be followed.

a. Before conduct of pre-dismantling inspection, turn off the 120-208V (60 cps, 3-phase), and the 115V (400 cps) switches located on the A3 control panel of the electronic rack for the particlar R & D window being dismantled.

b. Before detaching an assembly from the structure, provide for an adequate number of slings and hoists.

c. Prior to removal of an optical component or baffle, index mating parts by scribing alignment reference marks across three intersections.

d. Immediately after removing an assembly from the structure, cover the opening and the removed assembly with a clean plastic cover.

e. Cleanliness is of the utmost importance when handling optical elements. Wear lintless cotton gloves and hold the assemblies by their frames. In the event of removal of a glass element from its frame, hold the glass by the outer edges.

f. When a jackscrew has been installed for adjustment purposes, adjacent to any of the three socket head cap screws supporting a mirror or beamsplitter, be extremely careful when dismantling not to disturb adjustment of this screw or astigmatism and poor image will result.

4-22. Removal of the assemblies is accomplished by use of obvious procedures and in the following sequence. Installation is the reverse of removal.

a. TV input frame assembly

b. Celestial sphere and frame assembly

c. First mirror and frame assembly

d. MEP assembly

e. Illumination and occultation assembly

f. Illumination relay assembly

g. Celestial Sphere input frame assembly

h. MEP input frame assembly

4-23. When reassembling or installing any of the assemblies, each optical element should be cleaned as prescribed in Section VII. Realign all scribe and reference marks made at disassembly. Spacers and baffles must be re-installed as closely as possible to their original positions. Check all pneumatic tube pressures when re-installed.

4-24. LANDING WINDOW STRUCTURES. When removing any of the major assemblies of the rendezvous and docking window structures, either for dismantling of for replacement of an optical element, certain procedures should be followed.

a. Before conduct of pre-dismantling inspection, turn off the 120-208V, (60 cps, 3-phase), and the 115V (400 cps) switches located on the A3 control panel of the electronic rack for the particular R & D window being dismantled.

b. Before detaching an assembly from the structure, provide for an adequate number of slings and hoists.

c. Prior to removal of an optical component or baffle, index mating parts by scribing alignment reference marks across three intersections.

d. Immediately after removing an assembly from the structure, cover the opening and the removed assembly with a clean plastic cover.

e. Cleanliness is of the utmost inportance when handling optical elements. Wear lintless cotton gloves and hold the assemblies by their frames. In the event of removal of a glass element from its frame, hold the glass at its outer edges.

f. When a jackscrew has been installed for adjustment purposes adjacent to any of the three socket head cap screws supporting a mirror or beamsplitter, be extremely careful when dismantling not to disturb adjustment of this screw or astigmatism and poor image will result.

4-25. Removal of the assemblies is accomplished by use of obvious procedures and in the following sequence. Installation is the reverse of removal.

a. MEP assembly

b. Celestial sphere frame assembly

c. Front frame assembly

d. MEP input frame assembly

e. Illumination and occultation assembly

f. Main frame assembly

4-26. When reassembling or installing any of the assemblies, each optical element should be cleaned as prescribed in Section VII. Realign all scribe and reference marks made at disassembly. Spacers and baffles must be re-installed as closely as possible to their original positions. Check all pneumatic tube pressures when re-installed.

4-27. CELESTIAL SPHERE. (See figures 1-6 and 4-5.) The removal of the celestial sphere from the telescope is performed entirely from the outside of the instrument. However, assess to the celestial sphere mounting fasteners necessitates the removal of a cover panel and two smaller plates, attached to the cover panel on the rear of the telescope. Access to the celestial sphere mounting bolts is achieved as follows (see figure 1-6):

a. Disconnect the long cable, wire No. W1190 from the electronics cabinet, unit No. 10, at connector 13J15.

b. Remove the four screws attaching the pin half of the connector to the left side of the light shield panels.

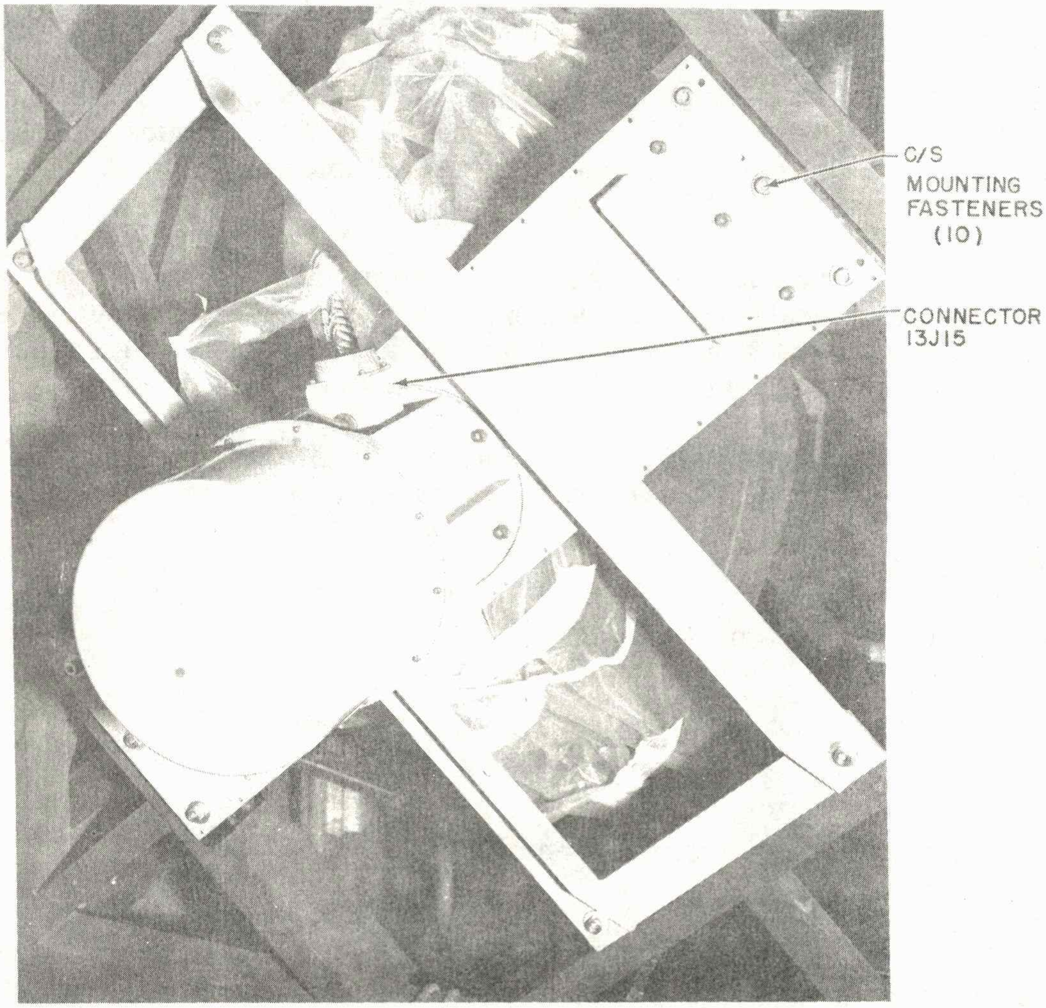


Figure 4-5. Celestial Sphere Mounting

c. Remove the screws attaching both portions of the light shield panels, remove the panels, and take care not to damage the gasket. Immediately attach the electrical connector half between the ribs of the celestial sphere drive barrel, as illustrated in figure 4-5.

d. Remove the joining strips and angles from the top, bottom, and sides of the celestial sphere cover panel.

e. Remove the panel-to-frame fasteners, and remove the panel from the telescope. The previous removal of the light shield panel permits clearance over the driving assembly of the celestial sphere, but care must be used not to damage the electrical leads.

4-28. Figure 4-5 illustrates the mounting arrangement of the celestial sphere to the telescope frame adapter brackets. The pin half of connector 13J15 is shown as attached to the drive barrel, as instructed in paragraph 4-27a., above.

CAUTION

> The center of gravity of the celestial sphere assembly is well forward of the X-shaped supports; i.e., toward the sphere. To avoid any possibility of damage to the celestial sphere when the mounting bolts are removed, it is essential that lifting slings be installed and attached to overhead hoisting gear, and made taut, before the mounting bolts and nuts are removed. In addition, slings must be attached to the driving mechanism barrel for the application of downward force in order to guide the sphere through the octagonal opening in the frame.

Similar to the MEP, the celestial sphere is attached to the telescope frame on adjustable angle brackets. The correct positioning of the angle brackets on the frame weldment was accomplished during the initial optical alignment of the telescope. Under normal circumstances, the positions of the angle brackets should not be changed. When all precautions have been taken that will provide manual control of the celestial sphere, remove the ten 1/2-13 inch socket head cap screws and nuts that attach the celestial sphere assembly to the mounting angle brackets. Each attachment consists of the socket head cap screw, nut, two 1/2 inch flat washers, and a 1/2 inch split lockwasher. Four technicians are required to remove the celestial sphere from the telescope frame.

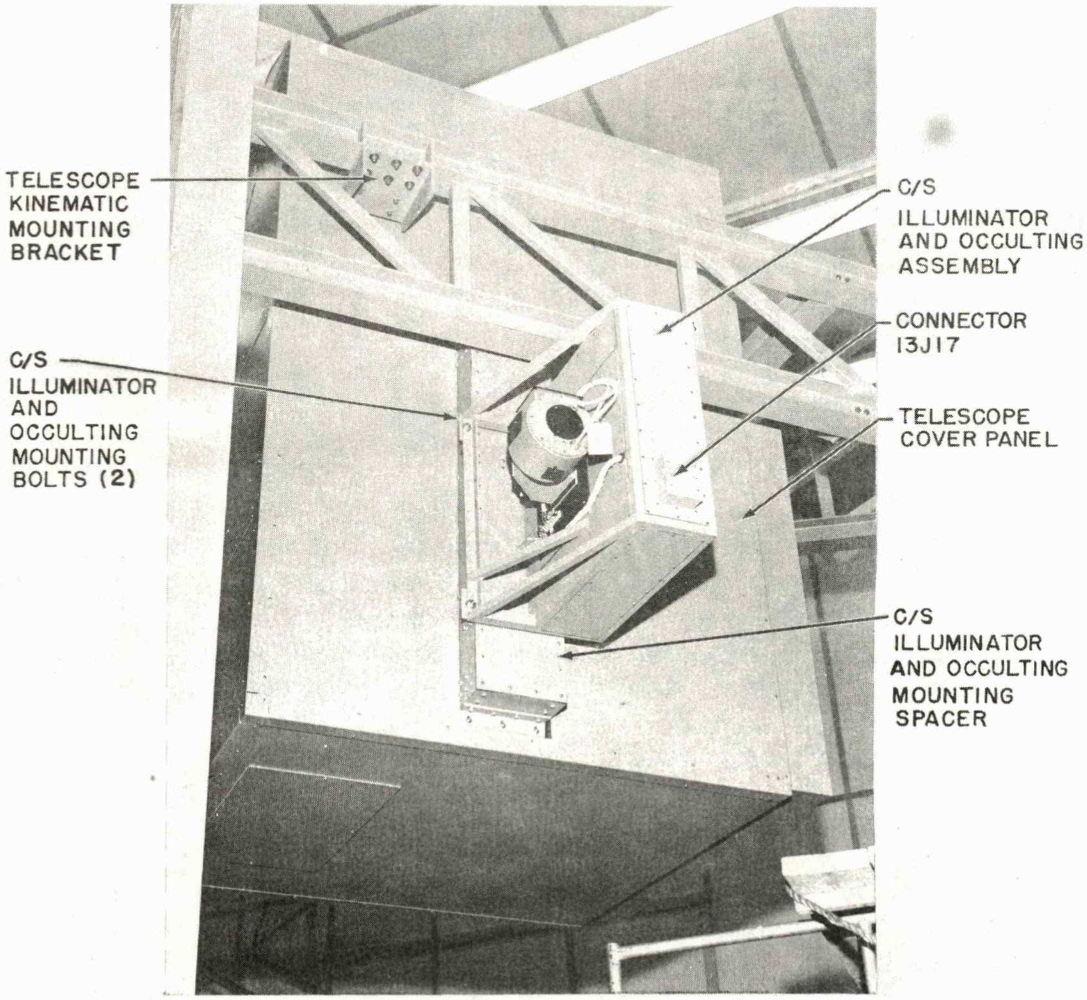
CAUTION

> Exercise extreme care as the sphere is moved through the opening formed by the mounting angle brackets and the frame members to avoid damage to the sphere or the support yoke.

Installation of the celestial sphere, following repair or maintenance, is accomplished by reversing the procedures described above and in paragraph 4-19.

4-29. C/S ILLUMINATOR AND OCCULTING ASSEMBLY. The removal of the C/S illuminator and occulting assembly requires prior removal of one telescope cover panel section with two small cover plates attached to it. The cover plates serve as light shields around a semi-rectangular light tube of the illuminator (see figure 4-6), projecting inside the telescope frame. The C/S illuminator and occulting assembly is mounted on a rectangular box structure (see figure 4-6) attached to the telescope frame. The box structure functions only as a spacer to properly position the illuminator light source inside the telescope and need not be detached from the telescope to remove the illuminator and occulting unit. Preliminary procedures for the removal of the illuminator and occulting unit are as follows:

a. Disconnect the long interconnecting cable assembly, wire No. 1187, at connector 13J17.



VSM4-6

Figure 4-6. AMS Telescope, Right Side and Bottom View

b. Remove the two small light shield cover plates, referred to above, from the telescope cover panel section.

c. Remove the joining strips and corner angles, and then remove the telescope cover panel section from the telescope.

d. Loosen, but do not remove entirely, the two illuminator and occulting unit fasteners.

NOTE

Each of the four fasteners, two of which are illustrated in figure 4-7, consists of a 1/2-13 inch socket head cap screw, two flat washers, one split lockwasher, and a 1/2-13 inch nut.

4-30. See figure 4-7. The final operations in the removal of the C/S illuminator and occulting assembly are as follows:

a. Remove the upper and lower occulting unit cover panels to obtain access to the nuts of the two fasteners; the upper fastener is hidden from view by the light tube housing.

CAUTION

Secure the assembly from possible damage by installing slings attached to overhead hoisting gear before removal of the fasteners.

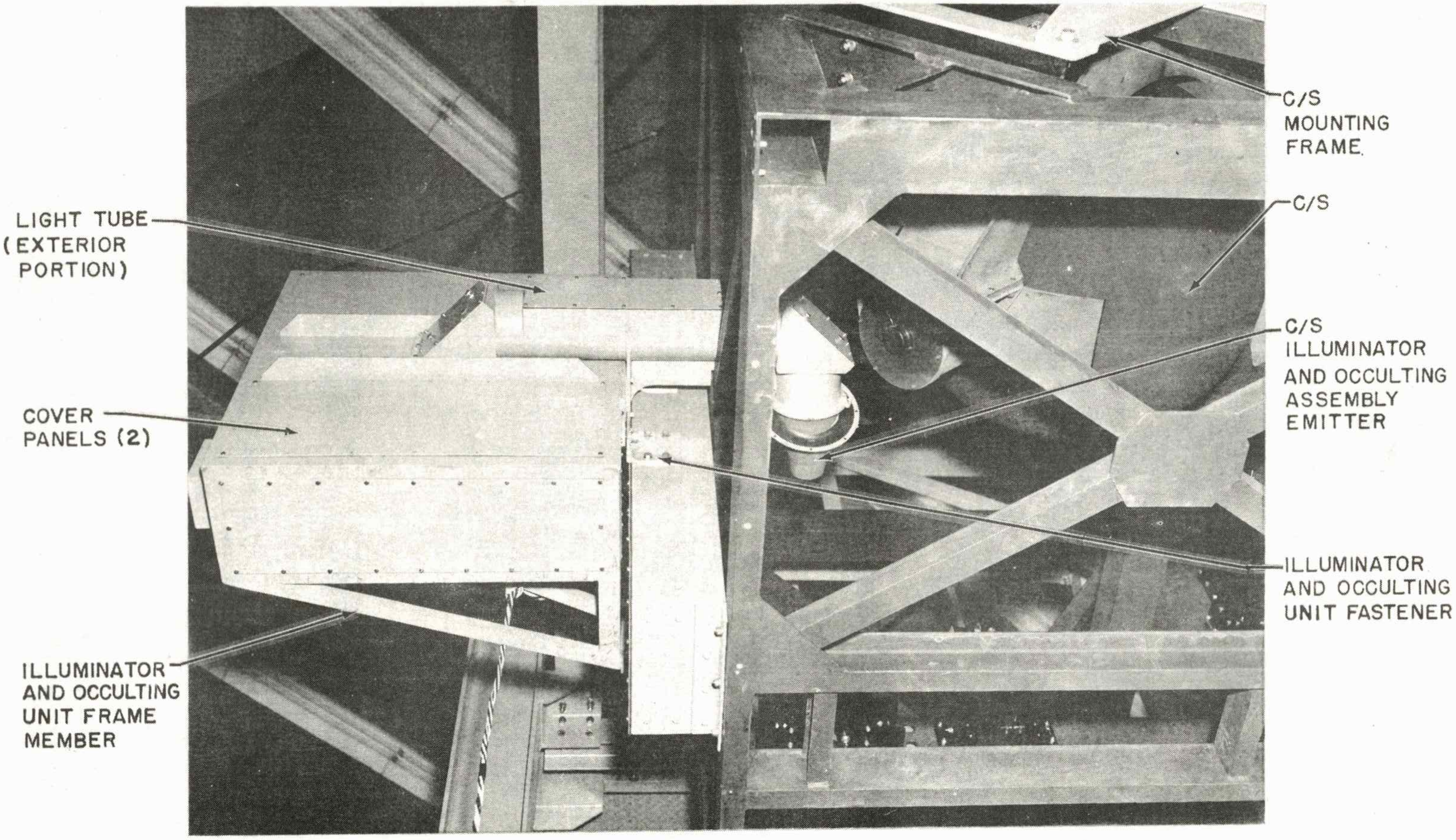
b. Remove the four fasteners and the C/S illuminator and occulting mounting bolts. Removal of the assembly from the telescope requires that it be rotated during the removal sufficiently enough to permit the light tube emitter (see figure 4-7) to clear the structural members of the telescope frame.

c. Remove the C/S illuminator and occulting assembly from the telescope. Replace the panel cover section with sufficient fasteners to hold it in place, and seal off the light tube opening as soon as possible after the illuminator assembly has been removed.

Installation of the assembly is achieved by reversing the procedures above and those described in paragraph 4-29.

4-31. SEXTANT.

4-32. With the exception of the eyepiece assembly, the removal of any assembly or subassembly of the sextant necessitates the removal of cover section(s), consequently exposing the interior of the sextant to airborne dust and other contaminants. Therefore, the importance of maintaining optimum cleanliness during these operations cannot be over-stressed.



VSM4.7

Figure 4-7. AMS Telescope, Right Rear Corner, Covers Removed

CAUTION

> The removal of assemblies on the optical bed plate, for the purpose of replacement of mechanically defective components, requires that certain pre-removal measurements be taken and recorded. The measurements are needed for correct positioning of the replacement assembly in order to maintain optical alignment. Therefore, prior to removal of an assembly mounted on the optical bed plate, refer to the paragraphs in Section VI of this manual for instructions regarding these measurements.

The necessity for removal of a fixed optical component may be considered as remote since, in a thermally controlled environment, breakage or other damage to the glass elements is unlikely.

4-33. EYEPIECE REMOVAL AND INSTALLATION. The removal and installation of the sextant eyepiece on the mounting panel inside the command module is an operational procedure, performed by the astronaut at specified times during a simulated mission. The procedure is the same as with the AMS telescope eyepiece. Two captive 1/4 inch socket head cap screws are removed, using a socket head cap screw key, and the eyepiece and associated prisms are removed as a unit. A window in the panel serves as a seal against entrance of foreign material when the eyepiece assembly is removed; this window should be inspected and cleaned, if necessary, with camel-hair brush before installation of the eyepiece. Exercise care when tightening the cap screws to insure and even seating of the mounting flange. Over-tightening could cause a warping of the casting, which, in turn, could cause damage and/or misalignment of the optical elements.

4-34. SLIDE MAGAZINE REMOVAL AND INSTALLATION. The normal condition of the sextant, in either the operational or non-operational mode, is with one of the landmark slides in the slide gate on the optical bed plate. Before the slide magazine can be removed from the carousel, the slide must be retracted into the magazine. This operation must be performed prior to removal of the landmark slide magazine removal cover (see figure 1-8), since removal of the cover electrically disables the slide actuation mechanism. Proceed as follows:

a. Energize the electronics cabinet equipment, as required, to supply power to the slide actuator electronics assembly and the slide actuating mechanism.

b. Depress the SLIDE RETRACT pushbutton on the slide actuator electronics assembly. The SLIDE INJECTED indicator light should go out and the SLIDE RETRACTED light be illuminated to indicate the slide has been retracted from the slide gate.

c. See figure 1-8. Loosen the four wing nuts, and release the swing bolts securing the circular cover to the carousel top cover. Using the handles provided, lift the cover straight up from the carousel top cover. The circular cover must

be lifted approximately four inches to clear the carousel. With the magazine cover lifted from the carousel housing, the MAG REMOVED indicator light on the actuator electronics assembly is illuminated.

d. See figure 4-8. Remove the three socket head cap screws that secure the slide magazine to the carousel hub.

CAUTION

The slide magazine must be maintained in an attitude so that the circular top plate is as nearly horizontal as possible, during the next operation, in order to prevent slides from falling out of the magazine.

e. Lift the slide magazine straight up from the carousel hub. When clear of the carousel top cover panel, lower the removed magazine to a secure support.

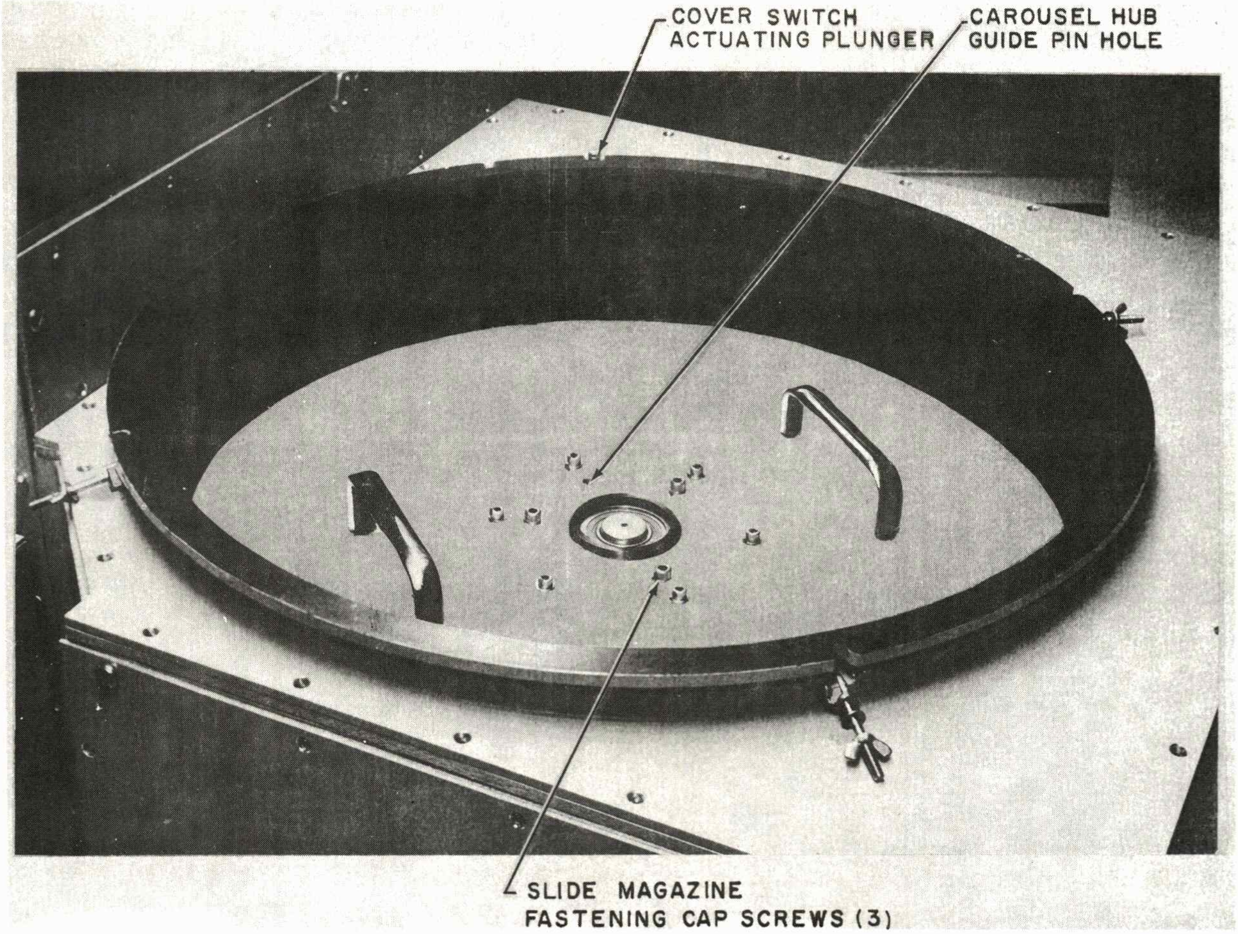


Figure 4-8. Carousel Housing with Slide Magazine Cover Removed

f. Unless a replacement magazine is to be installed immediately, cover the opening to the carousel interior to prevent entrance of dirt.

4-35. Installation of a replacement slide magazine is essentially the reverse of the procedures as stated in paragraph 4-34, however, the magazine must be suspended over the carousel hub so that, when lowered, the guide pin on top of the hub enters the guide pin hole in the magazine plate. After tightening the three socket head cap screws securing the magazine to the hub, check the carousel rotation and positioning, before installing the slide magazine cover as follows:

a. Place the toggle switch on the sextant slide selector section of the electronics cabinet test panel in the "TEST" position. Open the landmark side of the combined light source housing; and place the toggle switch therein in the "TEST" position, thus illuminating the landmark optical path.

b. Manually depress and hold the switch actuating pluger in the flange of the carousel cover panel.

c. Press pushbutton switch S1, SLIDE INJECT, on the slide actuator electronics assembly to inject a slide into the slide gate.

d. Turn the TENS and UNITS rotary switches on the test panel to "0-0".

The observer at the sextant eyepiece should see the slide in the slide gate retracted, the landmark optical path darkened and, after an interval, the test pattern slide should appear in the reilluminated optical path. Refer to the Functional Test, Section II, for the required results for slide positioning repeatability. Perform the functional test described to insure correct positioning of the slide magazine on the carousel hub. Following the checkout procedure; replace the slide magazine cover; return all toggle switches to "NORM", and deenergize the electronics cabinet.

4-36. INDIVIDUAL SLIDE REPLACEMENT. Individual slides can be installed in the slide magzine without removal of the magazine from the carousel as follows:

a. Perform steps a., b., and c., of paragraph 4-34.

b. Remove the carousel side cover panel, figure 1-8.

c. Rotate the slide magazine manually, by means of the handles, until the slide to be replaced is indexed with the spring-loaded retention pin, located to the left of the slide injection/retraction linkage.

d. Manually depress and hold the retention pin while the slide is extracted from the magazine and the replacement slide inserted; release the retention pin.

NOTE

Repeat procedures c. and d. to replace as many slides as desired.

e. Replace the slide magazine cover. Observe that actuation of the interlock switch results in an error signal that will cause the carousel to rotate to the original position (before manual rotation), and the slide at that position is injected into the slide gate.

f. Replace the carousel side cover panel. Deenergize the electronics cabinet.

4-37. ROTATING PRISM REMOVAL AND INSTALLATION. (See figure 4-9.) Removal of the rotating prism is accomplished as follows:

a. Loosen the four quick-action latches and remove the prism housing cover.

b. Disconnect the servo torque motor and resolver leads from terminal board, 12TB9, mounted inside the housing.

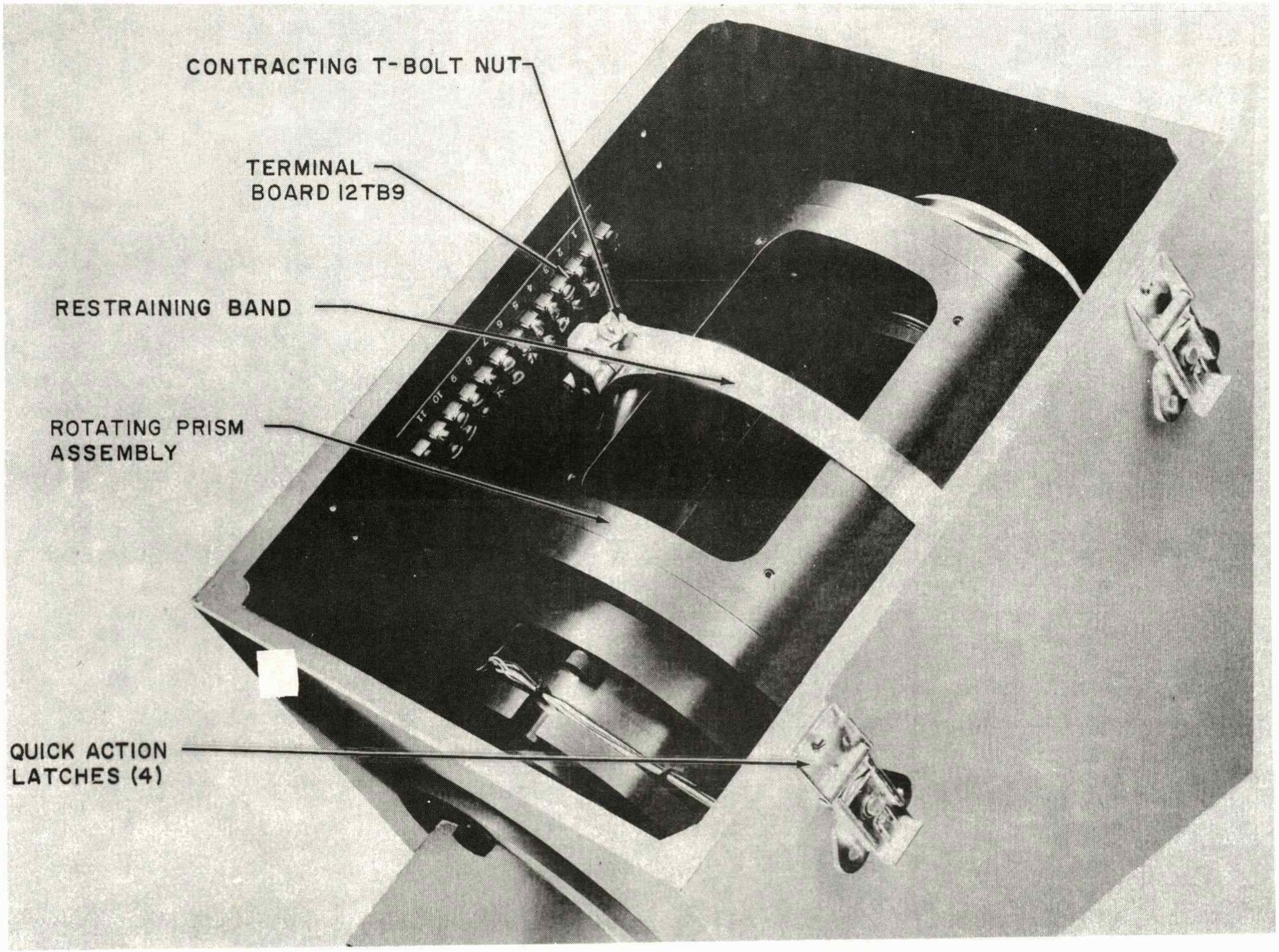


Figure 4-9. Rotating Prism Assembly (Wiring Disconnected)

c. Loosen the nut of the contracting T-bolt and separate the two ends of the restraining band. Lift the rotating prism assembly out of the housing. Installation of a replacement unit is the reverse of the above procedures, with the following exception: the restraining band is not connected, or only very loosely connected, until the replacement rotating prism assembly is electrically zeroed. Before proceeding with the zeroing, make sure the assembly is firmly seated against the positioning stop at the lower end of the supporting ways.

4-38. ROTATING PRISM ELECTRICAL ZEROING. With all electrical connections on terminal board 12TB9 made and securely tightened, proceed as follows:

a. Refer to paragraphs 2-27 and 2-28 and establish pre-test conditions for functional testing.

b. Observe the orientation of the image of the test pattern and the rotating reticle engraving as viewed through the sextant eyepiece. The X and Y axes of both pattern and reticle should appear indexed; however, unless the rotating prism is zeroed, the axes will not appear horizontal and vertical, respectively.

c. Following voice instructions from the observer-technician at the eyepiece, the cylindrical casing of the prism assembly is slowly and carefully rotated on its supporting ways in the commanded direction (clockwise or counterclockwise), while a technician at the electronics cabinet test panel maintains a zero dial reading for the rotating prism test resolver. When the image of the test pattern and the reticle engraving appear oriented correctly: The Y axes are vertical with +Y to the right; rotation of the assembly casing is halted; then the restraining band is connected and tightened.

d. Perform the functional test of the rotating prism assembly as described in Section II of this manual. If necessary, adjust the position of the assembly on the supporting ways, until deflection of the combined LOS is within permissible limits.

Complete the installation of the rotating prism assembly by installing and securing the rectangular cover plate. Deenergize the electronics cabinet.

4-39. SLIDE ACTUATOR MECHANISM REMOVAL AND INSTALLATION. (See figure 4-10.) The slide actuator mechanism assembly is mounted on the carousel gear box cover plate. The cover plate is designed with an extension, below the gear box, to provide a mounting surface for the actuator mechanism. The removal procedures are as follows:

a. Remove the front, back, and side panels of the carousel housing.

b. Loosen the clamping screws securing the hooked slide injection/retraction rod to the actuator linkage.

NOTE

> The normal condition of the sextant is with a slide injected into the slide gate on the optical bed plate. Therefore, when the carousel cover plates are removed, the slide injection linkage will be at the opposite end of the actuating mechanism than is illustrated in figure 4-10.

c. Hold the injection/retraction rod in the "slide injected" position and pull the connecting clamp off the end of the rod.

d. Refer to tables 3-2 and 3-3, and disconnect slide actuator leads from terminal board 12TB11.

e. Remove the four 1/4-28 x 1-3/4 inch socket head screws and spacers securing the two side plates of the mechanism to the carousel gear box cover plate, and lift the mechanism out of the carousel housing. Access to the four cap screw heads is gained by removal of the front and back cover panels described in a., above.

Installation of the replacement slide actuator mechanism is the reverse of the above procedures. However, prior to final installation of the cover panels, perform the functional test for landmark slide positioning, as described in Section II of this manual. Adjust the position of the injection/retraction rod in its clamp, or adjust the slide-in and slide-out microswitches, as required.

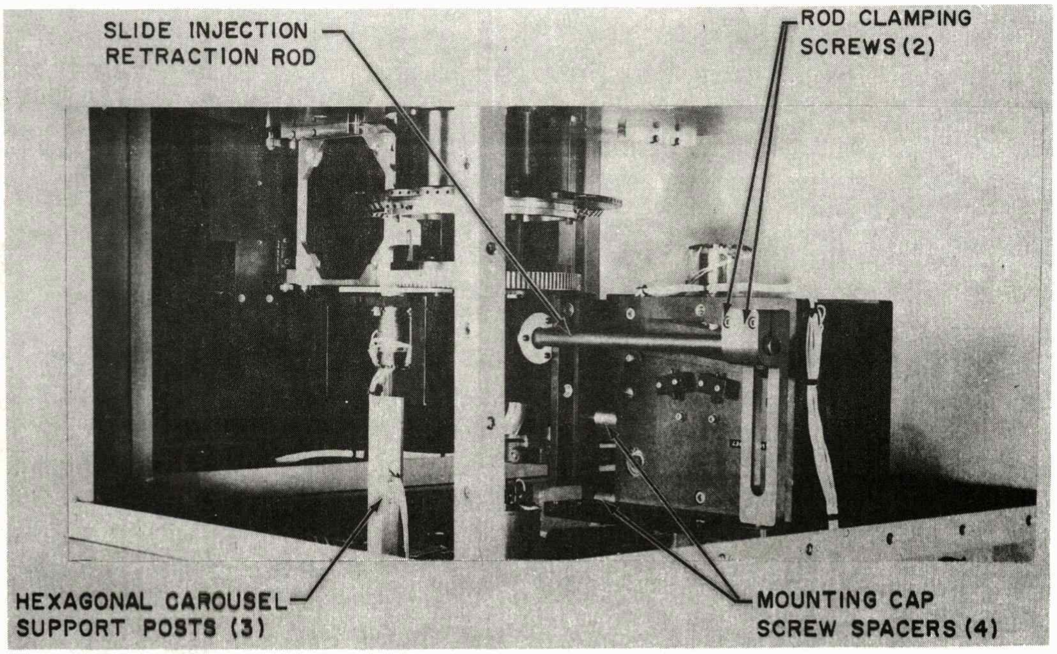


Figure 4-10. Slide Actuater Mechanism Mounting

CAUTION

The slide magazine must be maintained in an attitude so that the circular top plate is as nearly horizontal as possible, during the next operation, in order to prevent slides from falling out of the magazine.

4-40. CAROUSEL REMOVAL AND INSTALLATION. The carousel is mounted on the sextant support frame by three hexagonal posts, one of which is shown and called out on figure 4-10. Access to the cap screws securing the three posts to the frame is obtained by removing the carousel bottom cover panel. Remove the carousel assembly from the sextant as follows:

a. Remove the slide magazine. (Refer to paragraph 4-34.)

b. Remove the slide actuator mechanism. (Refer to paragraph 4-39.)

CAUTION

Due to prior removal of the slide magazine, the slide injection/retraction rod will be in the position illustrated in figure 4-10. Therefore, modify the mechanism removal procedures accordingly. To prevent damage to, or ejection of the rod from the carousel gear box, place the rod at the approximate mid-point of its travel and lash it in that position with clean cotton twine. Do not use adhesive backed tape to secure the rod.

c. Remove the plunger-actuated interlock switch from the underside of the carousel top cover panel. Do not disconnect the electrical leads from the switch, but remove any lacings that secure the leads into any bundle of wires.

d. Remove the carousel top and bottom cover panels.

e. Disconnect the carousel motor-generator and resolver leads from terminal board 12TB10. Release the leads from any wire bundles as indicated for the interlock switch leads in c., above.

f. While a technician holds the carousel gear box at both ends for stabilization, remove the three cap screws securing the hexagonal posts to the support frame. Lift the carousel out of the housing framework. Place the carousel on clean blocking that contacts the underside of the gear box to avoid the possibility of tipping over and subsequent damage.

Installation of a replacement carousel is essentially the reverse of the above, with the exception that the carousel must be mechanically aligned for correct slide injection and retraction, prior to final tightening of the securing cap screws in the hexagonal posts. Refer to Section VI for instructions.

4-41. SEXTANT REMOVAL AND INSTALLATION. In order to remove the rotating prism and eyepiece tube support weldment, see figure 1-7, the combined light source assembly, the sextant right side cover panel (adjacent to the telescope), and sextant assembly (less the eyepiece tube) must be removed from the supporting structure. Before removing the sextant from the structure, prepare a repair support frame. The repair support must be an open frame to permit access to the fasteners that secure the prism support casting and the light source assembly to the sextant support frame. Remove the sextant assembly, less eyepiece tube, as follows:

a. Disconnect the long wire assemblies W538, W539, W540, and W541 from connectors 12J1, 12J2, 12J3, and 12J4, respectively.

b. Remove the three socket head cap screws that secure the eyepiece tube to the rectangular rotating prism housing.

c. Attach overhead hoisting gear (one-ton capacity) to the three lifting lugs on the sextant.

d. Remove the three fasteners that secure the sextant to the supporting structure.

CAUTION

The hoisting and subsequent removal of the sextant from the supporting structure must be performed with the utmost care. Prevent any pendulous motion of the suspended sextant to avoid damage to the sextant eyepiece tube or the adjacent telescope.

e. Carefully hoist the sextant sufficiently to swing it clear of the supporting structure. Lower the sextant toward the prepared repair support frame. Prior to placing the sextant on the frame, remove the bottom front cover panel.

f. Place the sextant assembly on the repair support, making sure that the fasteners described above are accessible for removal.

Following the replacement of assemblies, the removal of which necessitated the removal of the sextant from the supporting structure, the required alignment procedures are performed as described in Section VI. Installation of the assembled sextant on the supporting structure is the reverse of the removal procedures.

4-42. ROTATING PRISM AND EYEPIECE TUBE SUPPORT WELDMENT REMOVAL AND INSTALLATION. To remove the rotating prism and eyepiece tube support weldment, perform the following:

a. Remove the sextant from the supporting structure. (Refer to paragraph 4-41.)

b. Remove the rotating prism from its housing. (Refer to paragraph 4-37.)

c. See figure 4-9. Disconnect the leads from connector 12J4 to terminal board 12TB9 at the terminal board.

d. Remove the sextant top cover and left and right side cover panels.

CAUTION

The weldment weighs approximately 55 pounds. Therefore, prior to removal of the mounting fasteners, adequate means for support must be provided.

e. Remove the fasteners attaching the weldment to the cover panel angles and the sextant support frame, and remove the weldment from the sextant assembly.

Installation of the support weldment is accomplished by reversing the above procedures.

4-43. COMBINED LIGHT SOURCE ASSEMBLY REMOVAL AND INSTALLATION. The combined light source assembly, mounted on the aft end of the sextant support frame, is attached to the frame by eighteen No. 10-32 cap screws threaded into the underside of the assembly base plate. Remove the combined light source as follows:

a. Remove the sextant from the supporting structure. (Refer to paragraph 4-41.)

b. Open the hinged cover on the landmark side of the assembly. After disconnecting the short cable harness connecting 12J5 to the slide actuator electronics assembly, remove the assembly by removing the two cap screws attaching it to the landmark side of the light source assembly. Disconnect all incoming leads to terminal board 12TB14.

c. Remove the eighteen fasteners attaching the light source assembly to the sextant frame, six on each long side and three on each end.

d. In removing the light source assembly from the frame, first tip it away from the sextant to permit pulling the electrical leads, disconnected in procedure b., through the hole in the base plate. Be sure the identifying terminal board number sleeves are not pulled off the leads during withdrawal.

The installation of the light source assembly is the reverse of removal, with one exception applicable only to the sextant unit at MSC-H. When securing the assembly to the frame, do not install the six No. 10-32 cap screws on the front, or optical bed plate, side. This modification is made in the sextant unit at MSC-H,

and permits removal of the combined light source assembly without first removing the sextant from the supporting structure.

4-44. OPTICAL BED PLATE ASSEMBLIES REMOVAL. (See figure 4-11.) The locations of the mounting pads for the operable assemblies as well as the fixed optics assemblies mounted on the optical bed plate are shown in figure 4-11. Table 4-1 lists the assemblies by name, the tapped mounting pads for each, and in the case of the operable assemblies, the associated terminal boards. The table also indicates the covers, panels, and assemblies that must be removed to gain access to the mounting cap screws.

NOTE

> In order to reduce realignment procedures to a minimum, the removal of an assembly should be accomplished without disturbing adjacent assemblies, whenever possible. This means that flexible shafts, universal joint extensions, etc., on socket head screw keys should be employed, wherever possible, to avoid the removal or displacement of adjacent assemblies.

4-45. An examination of the assembled sextant, accompanied by study of figure 4-11 will indicate to an experienced maintenance technician the most practical manner in which to approach the removal of an assembly from the optical bed plate. No attempt is made, in this manual, to call out every operation that must be performed, such as the removal of wire bundle clamps and lacings, since these will be obvious. The removal of certain assemblies involves some prior-to-removal operations, in addition to the accessibility removals listed in table 4-1. These are covered in succeeding paragraphs.

4-46. Landmark and Starfield Rhomb Scanners. After obtaining access to the assembly, as indicated in column 4 of table 4-1, the Alpha and Beta scanning rhomboids should be brought to their approximate mechanical zero positions. The sector gear support arms are then lashed to the adjacent end plates. This will prevent movement of the rhomboids during the removal and minimize damage to the optical elements or the gearing. The Alpha rhomb scanner servo system in the landmark rhomb scanner is electrically connected at terminal board 12TB6, mounted on top of the assembly. Therefore, the leads from connector 12J3 must be disconnected from 12TB6. The leads from the terminal board to the motor and resolvers may be left connected during the removal. In the case of the starfield rhomb scanner, terminal board 12TB13, mounted on top of the assembly, is the electrical connection point for the starfield generator motors and resolvers. The terminal board itself should be removed from the scanner assembly, and the lead connections may be left undisturbed.

4-47. Landmark Slide Gate. Following the accessibility removals listed in table 4-1, the light tube, attached to the slide gate, must be removed to permit removal of the slide gate from the optical bed plate. The light tube is held in place by a

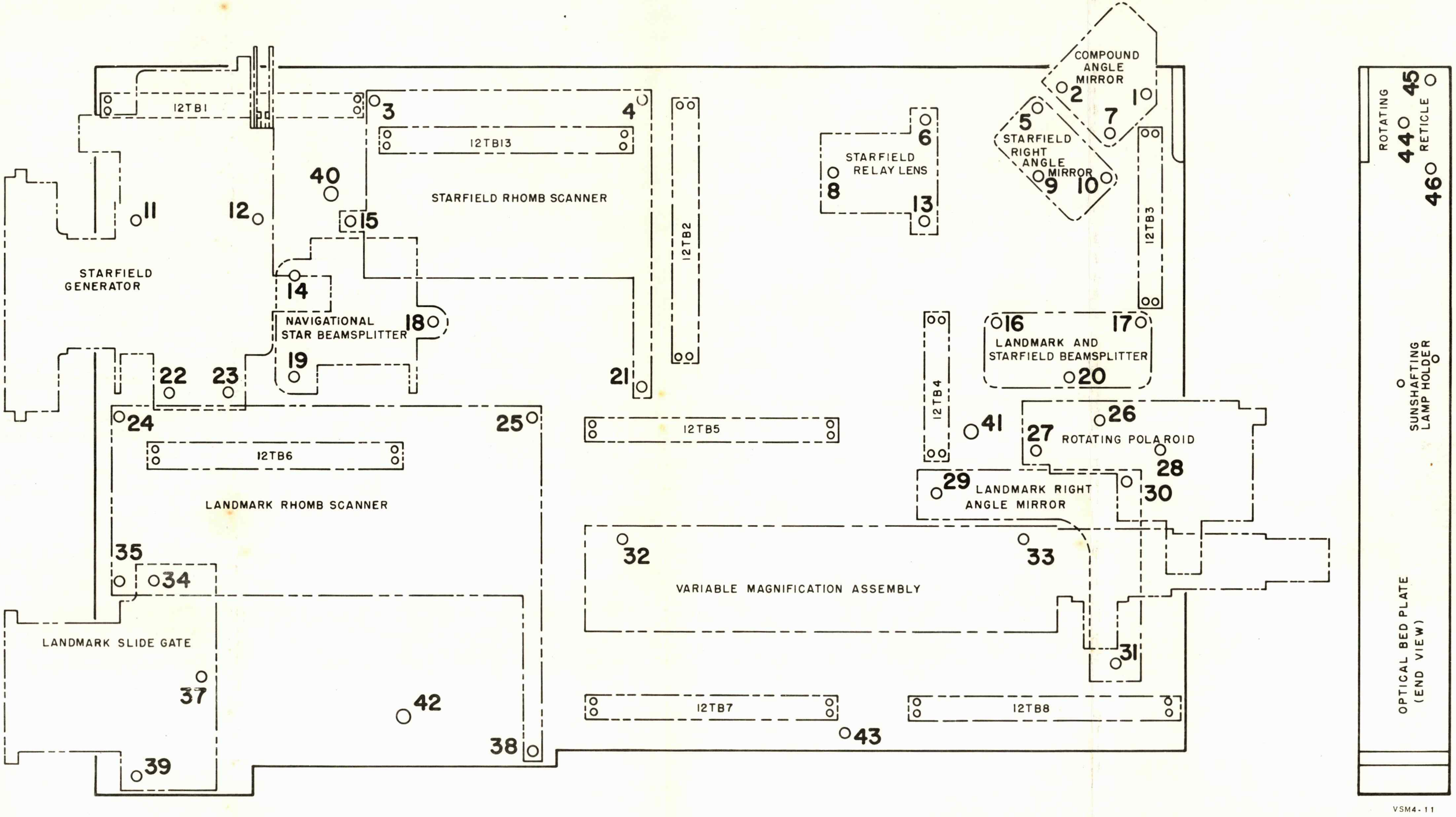


Figure 4-11. Mounting Pad with T.B. Locations

Table 4-1. Optical Bed Plate Assemblies Removal Data

Assembly	Mounting Pad Numbers	T.B. Number	Prior Removals for Accessibility
Compound Angle Mirror	1, 2, 3,	N/A	Top Cover
Starfield Right Angle Mirror	5, 9, 10	N/A	Top Cover
Starfield Relay Lens	6, 8, 13	N/A	Top Cover
Starfield Rhomb Scanner	3, 4, 15, 20	12TB2 12TB5	Top Cover
Starfield Generator	11, 12, 22, 23	12TB13	Top Cover and Combined Light Source Assembly
Navigational Star Beamsplitter	14, 18, 19	N/A	Top Cover, Light Source Assy., and Starfield Gen
Landmark Rhomb Scanner	24, 25, 35, 38	12TB6 12TB7	Top Cover and Combined Light Source Assembly
Landmark Slide Gate	34, 37, 39	N/A	Top Cover, Light Source Assembly, Slide Magazine, and Carousel Top Cover Panel
Variable Magnification	32, 33, 43	12TB8	Top Cover and Left Side Cover Panel
Landmark Right Angle Mirror	29, 30, 31	N/A	Top Cover and Rotating Polaroid Assembly
Rotating Polaroid Filter	26, 27, 28	12TB4	Top Cover
Landmark/Starfield Beamsplitter	16, 17, 20	N/A	Top Cover
Rotating Reticle	44, 45, 46	12TB3	Rotating Prism and Eyepiece Support Weldment
Optical Bed Plate	40, 41, 42	N/A	Removal of the Optical Bed Plate necessitates removal of all assemblies thereon

half-circle clamp, attached to the slide gate by two No. 6-32 socket head cap screws. Removal of the light tube clamp permits the light tube to be pulled straight out of the slide gate. The diffuser disc will remain in the light tube. After removal of the hold-down cap screws, the slide gate is removed by maneuvering it off the optical bed plate toward the carousel.

4-48. OPTICAL BED PLATE ASSEMBLIES INSTALLATION. Each assembly on the optical bed plate, with the exception of the rotating reticle, is mounted on rectangular, tapped pads at each of the fastener points illustrated in figure 4-11. The pads have a nominal thickness of either 3/8 or 1/2 inch, depending on the assembly. During the initial assembly of the sextant, and more particularly at the time of assembly alignment, each pad was individually adjusted (both for thickness and parallelism (or angularity) between upper and lower surfaces) to position the assembly mounted thereon so that the landmark and starfield optical paths are at all times within plus or minus 0.0003 inch of a reference plane established by the variable magnification assembly. However, the tolerance for certain assemblies, notably the variable magnification assembly itself and the landmark right angle mirror, is even more rigid. Here the landmark LOS must be well centered within the 0.0013 inch width of the lines on the landmark test pattern for the entire travel of the variable magnification lens halves between maximum and minimum magnification. Instructions for achieving this very fine alignment, when an original assembly is removed from the optical bed plate and a replacement assembly installed, are contained in Section VI of this manual.

4-49. Following the required alignment procedures, the installation and tightening of the fastener cap screws, electrical connections, and the electrical zeroing of the newly installed assembly, if operable, must be performed. Zeroing instructions for the two-speed rhomb scanners, the one-speed d-c torque motor servos, and the a-c torque motor servos are contained under the appropriate paragraph headings. Zeroing of the rotating reticle is identical with the zeroing of the rotating prism, as described in paragraph 4-38 with the exception that the viewing of the image on the reticle is made through a microscope, screwed into the rotating reticle assembly with an adapter bushing. When the rotating reticle is zeroed and axially positioned in the combined LOS, the clamping screws of the rotating reticle assembly are tightened, and the rotating prism and eyepiece tube support weldment is installed.

4-50. When the completely assembled sextant is re-installed in the supporting structure, perform the Functional Testing described in Section II to assure satisfactory sextant performance.

4-51. TELESCOPE/SEXTANT ELECTRONICS CABINET.

4-52. GENERAL. The electronics cabinet components are essentially of modular design, removal and installation procedures for its assemblies and their components are accomplished quickly and easily. Therefore, this section merely summarizes the required procedures, noting areas of special interest.

4-53. POWER SHUTDOWN. The three phase circuit breaker and the 400 cps toggle switch on the power control panel should be set OFF, before any assembly is removed from the electronics cabinet.

4-54. REMOVAL OF ASSEMBLIES. Since all assemblies and components are mounted in accordance with standard electronic practice, no special tools are required. The following paragraphs generally consider the mounting of each assembly and give whatever procedures are helpful in the course of removal.

4-55. Test Panel. To remove the test panel, unplug connectors 9P17 through 9P22 from their associated sockets and remove eight bolts securing the test panel to the electronics cabinet.

CAUTION

Support unit from rear, during removal, to prevent its falling on rear components.

4-56. Power Control Panel. To remove the power control panel proceed as follows:

a. Unplug connectors J1 and J2.

b. Disconnect 400 cps power leads 20-989 from 9A2TB3.

c. Disconnect 60 cps power leads 14-888 from 9A2TB4.

d. Remove the four screws securing the power control panel to the electronics cabinet.

CAUTION

Care should be taken to avoid damaging the thermal relay plug which protrudes through the bottom of the unit.

4-57. D-C Power Supplies. To remove the d-c power supplies, proceed as follows:

a. Remove the input and output connections from the rear of the supply.

b. Remove the front mounting bolts and slide the supply out on support rails.

4-58. Servo Amplifiers. Each servo amplifier is individually secured by means of two thumb screws which are accessible from beneath the chassis. Since the enclosures for the a-c servo amplifiers and the d-c torque motor electronics

assemblies are secured in the same manner, their removal procedures are the same and are as follows:

a. Make sure power is turned off.

b. Unplug the associated connector.

c. Remove two thumb screws from underneath the chassis and lift enclosure off chassis.

4-59. Digital to Resolver Converters. The components comprising the DRC's for the sextant starfield and sextant landmark selection systems are installed on the test panel chassis. The DRC transformers are mounted on the chassis together with the other test panel components. The associated relays are mounted on a separate sub-chassis which is secured to the under surface of the test panel chassis and are protected by a dust cover. To obtain access to these relays, remove the four machine screws securing the dust cover to the sub-chassis.

4-60. Ventilation Duct Air Filters. To remove air filters, proceed as follows:

a. Remove Access Cover which is secured to Ventilation Cover by 12 machine screws.

b. Slide filters out. Each filter is in two parts which must be removed separately. Pry up each filter half separately and remove through opening.

4-61. Installation of Assemblies. In each case, the electronic assemblies may be installed by reversing the removal procedures.

4-62. OUT-THE-WINDOW DISPLAYS.

4-63. Removal and installation of the out-the-window displays consists mainly of removing various subassemblies. These subassemblies include the three main inputs to the visual system through the optical display units. They are the television input, the celestial sphere input, and the mission effects projector input. These three inputs are further broken down into their various component parts, where applicable, and are described in detail under the appropriate heading or subheading in the following paragraphs.

4-64. CELESTIAL SPHERE.

4-65. Removal and installation procedures for the C/S subassemblies are given in the following paragraphs.

CAUTION

The following precautions must be observed at all times:

a. Do not touch the C/S with bare hands.

b. Do not smoke within 10 feet of the C/S since this will dull the lustre of the ball bearings.

c. Wear safety goggles at all times.

d. Use the C/S lifting handles to remove the sphere.

4-66. REMOVAL AND INSTALLATION OF THE C/S FROM ITS WINDOW. Removal of the C/S from its window is accomplished as follows:

a. Place shackles through the two holes provided in the angle (see figure 1-40).

b. Place hooks of chain hoist through shackles and cinch up till chains are just taut.

c. Remove the 10 bolts on the plate mounting.

d. Guide the C/S through its mounting port.

e. Installation is the reverse of removal.

4-67. REMOVAL AND INSTALLATION OF THE C/S SOUTHERN HEMESPHERE. Removal of the south pole of the C/S may be required to obtain access to the pitch axis resolvers, torque motors, or other electrical elements. Removal should be conducted upon completion of the removal of C/S from its window (refer to paragraph 4-66).

a. Remove the plug captive screw, lock washer, and captive screw from the celestial sphere.

b. Thread the celestial sphere access cover removal tool in threads vacated by the screws and lock washers and lift the C/S south pole.

c. Installation is the reverse of removal.

4-68. REMOVAL AND INSTALLATION OF THE PITCH AXIS RESOLVER. Removal and installation of the pitch axis resolver may be accomplished after the removal of the C/S south pole (refer to paragraph 4-66).

a. Remove the fil.-head screw (size 4-40), lockwasher, and flat washer holding the resolver.

b. Installation is the reverse of removal and may be accomplished upon completion of the C/S zeroing procedures described in Section VI.

4-69. REMOVAL AND INSTALLATION OF THE YAW AXIS RESOLVER. Removal of the yaw axis resolver is accomplished as follows:

a. Remove the C/S from its window (refer to paragraph 4-66).

b. Remove resolver mount.

c. Remove the resolver.

d. Installation is the reverse of removal upon completion of the C/S zeroing procedures described in Section VI.

4-70. REMOVAL AND INSTALLATION OF THE ROLL AXIS RESOLVER. Removal of the roll axis resolver is accomplished as follows:

a. Remove the cover assembly. (See figure 1-40.)

b. Remove resolver.

c. Installation is the reverse of removal upon completion of the C/S zeroing procedure described in Section VI.

4-71. REMOVAL AND INSTALLATION OF THE MEP SUB-ASSEMBLIES. (See figure 4-12.)

4-72. Removal and installation of the MEP sub-assemblies is provided in the following paragraphs. Calibration is provided in Section VI. Before a sub-unit removal is effected, it is necessary to remove all cables and disconnect all air lines to the sub-unit. The cables to be separated are obvious upon inspection and, therefore, are not covered in this instruction.

4-73. Care should be taken to ensure that spacers and shims are not lost. During sub-assembly removal, shims and spacers (whenever applicable) should be attached (be tape or some other fastening device) to their respective frame/mount holes. In some instances, this was done during MEP assembly. Due to the use of spacers and shims of different thicknesses, it is important that all spacers always be kept for use in their original position.

4-74. REMOVAL AND INSTALLATION OF THE MISSION FILM LAMP ASSEMBLY. (See figure 4-13.)

a. Removal: Removal of the Mission Film Lamp is accomplished as follows:

(1) Remove six securing bolts located around the mounting collar of the Mission Film Lamp Assembly.

(2) Slide the Mission Film Lamp Assembly out from the MEP framework.

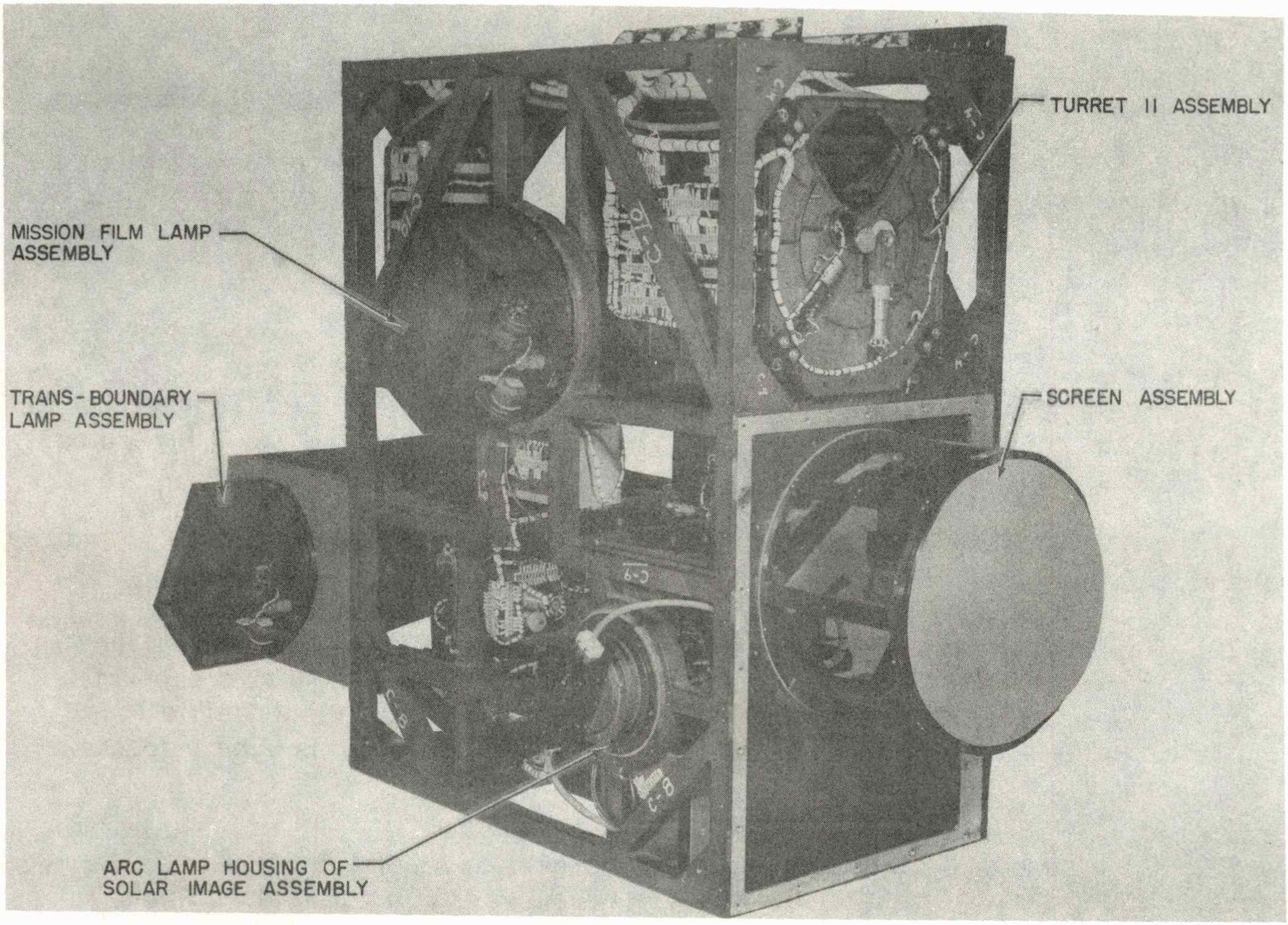
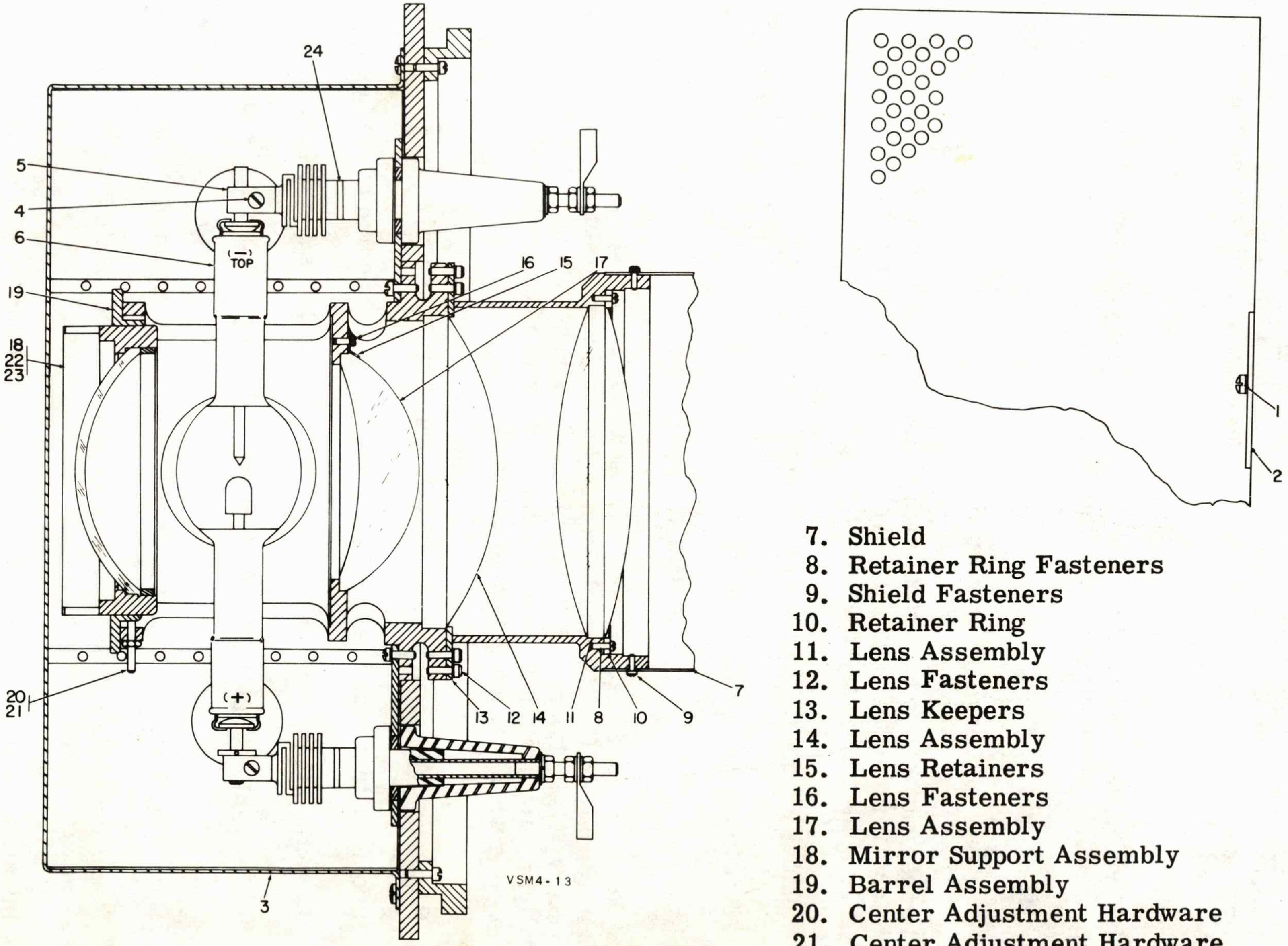


Figure 4-12. Mission Effects Projector



1. Cover Securing Screws
2. Guard
3. Lamp Cover
4. Clamp Securing Screws
5. Lamp Mounts
6. Arc Lamp
7. Shield
8. Retainer Ring Fasteners
9. Shield Fasteners
10. Retainer Ring
11. Lens Assembly
12. Lens Fasteners
13. Lens Keepers
14. Lens Assembly
15. Lens Retainers
16. Lens Fasteners
17. Lens Assembly
18. Mirror Support Assembly
19. Barrel Assembly
20. Center Adjustment Hardware
21. Center Adjustment Hardware
22. Mirror Support Assembly Fasteners
23. Mirror Support Assembly Fasteners
24. Shim

Figure 4-13. Mission Film and Transboundary Lamp Housing Assemby

b. Installation: Installation of the Mission Film Assembly into the MEP is the exact reverse of the Removal procedures presented above.

4-75. Removal and Installation of the Mission Film Lamp Assembly, Arc Lamp. (See figure 4-13.) Arc lamps used with the Mission Film Lamp Assembly can be removed and replaced without removing the Mission Film Assembly from the MEP.

NOTE

Arc lamps for the Mission Film Assembly must have aligning collar installed by the Farrand Optical Co., Inc.

a. Removal

WARNING

Arc lamps, when ignited, give off ultra violet rays. Baush and Lomb Ray Ban protective goggles, type Z-301E, must be worn whenever ignited lamp is exposed.

(1) Remove all power from the lamp (6).

(2) Allow lamp to cool for 45 minutes.

WARNING

Allow lamp to cool for 45 minutes after power is removed. Internal pressure of the Mission Film Arc Lamp is temperature dependant. These lamps, when hot, maintain extremely high internal pressure and must not be handled. Wear protective gloves and goggles whenever arc lamps are exposed.

(3) Remove cover securing screws (1), guard (2), and cover (3).

(4) Loosen clamp securing screws (4) at the top and bottom of the lamp.

(5) Move the lamp in an upward direction until it clears the lower mount.

(6) Tilt the lamp slightly off vertical, and slide it down out of the upper mount.

(7) Lower the lamp through the access hole in the bottom of the barrel.

(8) Remove any shims used under the lamp. (These shims must be saved and used when installing new lamp.)

(9) Install a protective shield around the central portion of the lamp.

b. Installation. Installation of the Mission Film Lamp is accomplished as follows:

(1) Remove the lamp protective shield.

(2) Wash the new lamp with distilled water and alcohol.

(3) Insert cathode end of the lamp through the bottom access opening in the barrel.

(4) Tilt the lamp off vertical and slide upward into the top mount (5).

(5) Insert shims (removed in removal step number 7).

(6) Slide the lamp downward into the lower mount (5).

(7) Engage clamps and mounts.

(8) Set the pre-focused lamp collar so that it rests on the upper surface of the lower lamp mount.

(9) Insure that the lamp evacuation tip is orthogonal to the optical axis of the condenser assembly.

(10) Tighten the lower clamp screw (4) so that the lamp is held securely.

(11) Tighten upper clamp screw (4) to a snug fit. (This clamp is used for alignment only, it must allow freedom of movement for thermal expansion).

(12) Install lamp cover (3) and guard (2) with screws (1).

(13) Ignite lamp according to the turn on procedure outlined in Section II.

(14) Observe lamp for uniformity of illumination at exit pupil of display. The uniformity of illumination can be adjusted by rotating the lamp in the clamp about an axis passed through the length of the lamp. Observe a 45 minute cool down period before adjusting the lamp.

CAUTION

The lamp "evacuation tip" must be kept clear of the cone of illumination imaged by the adjacent condenser lenses.

(15) Replace MEP protective cover and secure with X bolts.

4-76. Removal and Installation of the Mission Film Lamp, Condenser Assembly. (See figure 4-13.)

a. Removal.

(1) Remove Mission Film Lamp Assembly from the MEP according to paragraph 4-74.

(2) Remove shield (7) and fasteners (9).

(3) Remove in sequence: retainer ring (10) and fastener (8), and lens (11).

(4) Loosen fasteners (12) and slide four keepers (13) away from the center of the housing.

(5) Remove lens (14).

(6) Remove three retainers (15) and fasteners (16).

(7) Remove lens (17).

b. Installation.

(1) With the aid of a vacuum suction cup install lens (17) into its seat.

(2) Install retainer (15) and secure with fasteners (16).

NOTE

The remaining lenses of the condensing lens barrel are shielded and should not require any maintenance.

(3) Install lens (14) into its seat and slide keepers (13) toward the center of the unit so that a shim (or feeler gauge) of .002 in. can be inserted between each keeper and lens. This shim is used as a gauge for spacing. Lock the keeper fasteners and remove shims.

(4) Install lens (11) so that the surface of greatest curvature (smallest radius) faces toward the lamp. Install assembly retainer ring (10), and fasteners (8) and (9).

(5) Replace light shield (7) and fasteners (8).

(6) Align the lens as described Section VI. After this alignment is completed, install the Mission Film Lamp Assembly into the MEP and install covers according to paragraph 4-676.

4-77. Removal and Installation of the Mission Film Lamp, Mirror Assembly. (See figure 4-13.)

a. Removal. Removal of the Mission Film Lamp Assembly mirror is accomplished as follows.

(1) Remove the Mission Film Lamp Assembly from the MEP according to paragraph 4-74.

(2) Remove guard securing screws (1).

(3) Remove guard (2).

(4) Remove cover securing screws (1).

(5) Remove cover (3).

(6) Scribe the Mirror Support Assembly (18) and Barrel Assembly (19) so that at installation the orientation will be maintained.

(7) Loosen only two of the centering adjustment hardware (20) and (21).

(8) Remove fasteners (22) and (23) and axially slide the mirror and mirror support bracket away from the lamp.

(9) After the mirror support assembly is clear of the Mission Film Lamp Assembly, remove the mirror retainer and the mirror.

NOTE

Do not advance or retract the adapter located within the threaded section of the mirror support assembly.

b. Installation. Installation of the Mission Film Lamp Assembly Mirror is accomplished as follows:

(1) Using a suction cup holder install the mirror into the mirror bracket assembly.

(2) Secure mirror in place with retainer ring.

(3) Install mirror support assembly into the Mission Film Lamp Assembly lens barrel (19).

(4) Align scribe marks on mirror bracket assembly (18) and lens barrel (19). Refer to step (6) in the removal instructions.

(5) Tighten the two adjusting screws.

(6) Secure the mirror bracket assembly with fasteners (22) and (23).

(7) Install cover (3) and secure with cover securing screws.

(8) Install guard (2) and secure with guard securing screws.

4-78. REMOVAL AND INSTALLATION OF THE TURRETS. (See figure 4-14).

a. Removal.

NOTE

Due to the weight, size, and awkwardness in handling of this assembly, and since this assembly should be handled with extreme care, it is recommended that three technicians be used for this particular removal procedure.

(1) Remove the appropriate turret cover (for turret I or II) and turret cover screws from the MEP frame assembly.

(2) Remove relay lens No. 1 as described in paragraph 4-82.

(3) Scribe spacers (1), and scribe mounting frame (see figure 4-14).

(4) While holding turret in place, remove turret fasteners (2).

(5) Lift the turret off its dowel pins, and guide it gently out of the MEP.

b. Installation. Installation procedures are the reverse of removal.

4-79. Removal and Installation of the Turret Servo Drive. (See figure 4-14.)

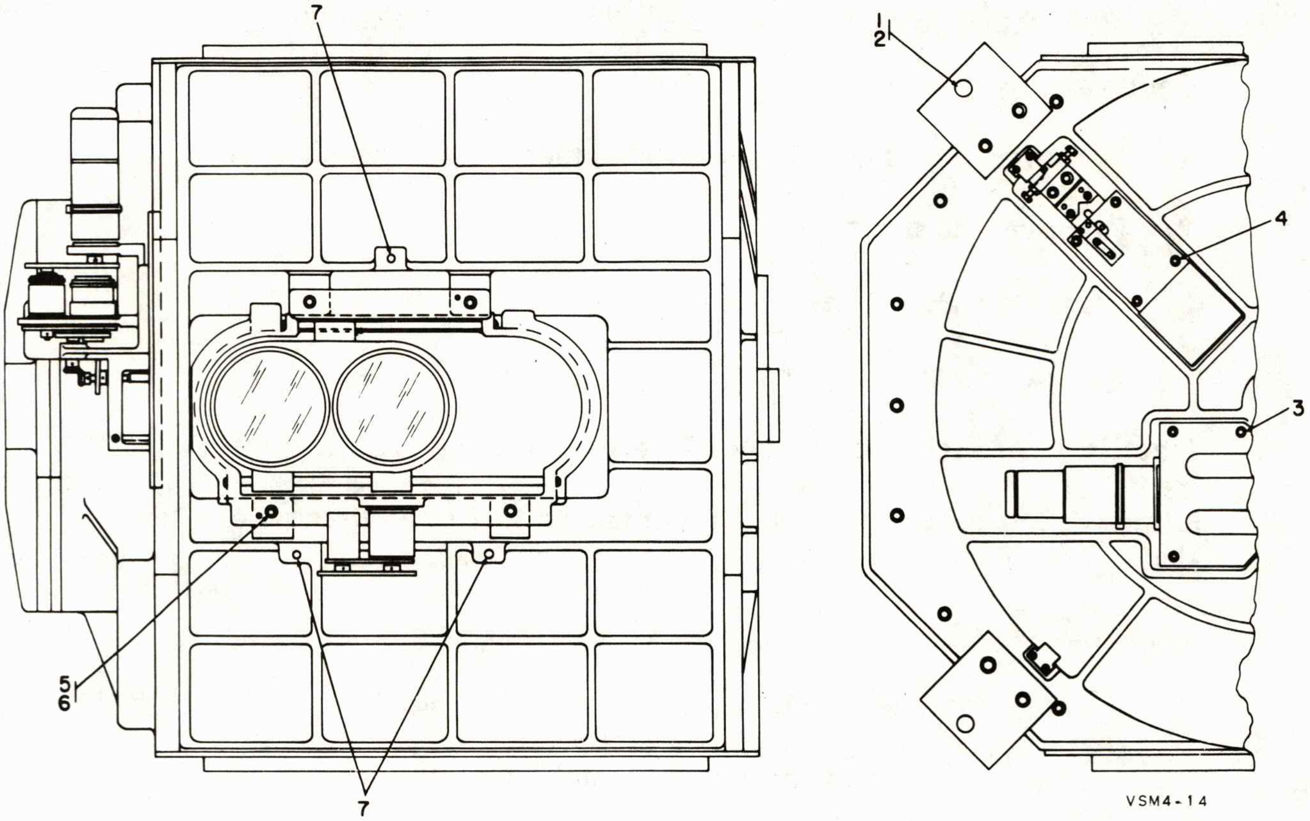
a. Removal.

(1) Remove the appropriate turret cover as described in paragraph 4-78a.

(2) Remove the fasteners (3).

(3) Remove the servo motor.

b. Installation. Installation procedures are the reverse of removal.



1. Turret Mounting Spacers
2. Turret Mounting Fasteners
3. Servo Drive Fasteners
4. Solenoid Fasteners
5. Distortion Lens Spacers
6. Distortion Lens Fasteners
7. Relay Lens Mount

Figure 4-14. Turret Assembly

4-80. Removal and Installation of the Turret Solenoid. (See figure 4-14.)

a. Removal.

(1) Remove turret cover as stated in paragraph 4-78a.

(2) Remove fasteners (4).

(3) Remove the solenoid assembly.

b. Installation. Installation procedures are the reverse removal.

4-81. Removal and Installation of the Distortion Lens Assembly. (See figure 4-14.)

a. Removal.

(1) Remove relay lens No. 1 as described in paragraph 4-82.

(2) Remove fasteners (6).

(3) Scribe spacers (5).

(4) Remove distortion lens.

b. Installation. Installation procedures are the reverse of removal.

4-82. Removal and Installation of the Turret No's. I or II Relay Lens No. 1 (Collimator). (See figure 4-14.)

a. Removal.

(1) Remove fasteners (7).

(2) Lift assembly from its dowel mounts and remove.

b. Installation. Installation procedures for this assembly are the reverse of removal.

4-83. Removal and Installation of the Cassettes. (See figure 4-15.)

a. Before removing a cassette, align it with the access hole of the turret by performing the following steps pertaining to test panel A-19 of the cabinet concerned:

(1) Following the turn-on procedures pertaining to the cabinet concerned, as described in Section II, set the Off-Course Command Potentiometer I or II (depending on turret) of Test Panel A-19 to midway between - and +.

(2) Set Turret No. I or II Man. Cassette switch to the position pertaining to the cassette being removed, i.e. A, B, C, or D.

(3) Depress Turret I or II Turret Index switch.

b. Removal.

(1) Turn power off.

(2) Attach cassette removal handle , spring clip-mounted to the sliding door of the cassette access hole, to cassette by fastening the captive female caps of the handle to the male studs of the mounting flanges (1).

NOTE

The tool for accomplishing steps (3) and (4) is spring clip-mounted to the sliding door of the cassette access hole.

(3) Turn gib locking screw (2) counter-clockwise approximately two turns, thus releasing the cam lock on the slide.

(4) Disengage locking screw (3) by turning it counter-clockwise. Screw is disengaged when cassette can be moved freely toward the access hole.

(5) Remove cassette by pulling cassette removal handle slowly toward access hole with one hand, and meanwhile, placing the other hand at the edge of the cassette casting. Carefully ease the cassette away from the dovetail guides in the cassette mount of the turret and through the turret access hole.

NOTE

A-C servo driven cassettes are not interchangeable with d-c servo driven cassettes.

c. Installation.

(1) If cassette mount for cassette to be installed is not aligned with access hole in the turret, first perform preliminary alignment steps as described in paragraph a., steps (1) thru (3) of this section.

(2) Installation procedures are the reverse of removal.

(3) Upon completion of cassette installation, set the Off-Course control of Test Panel A-19 of the cabinet concerned, as required, to center the film on the optical axis of the turret concerned.

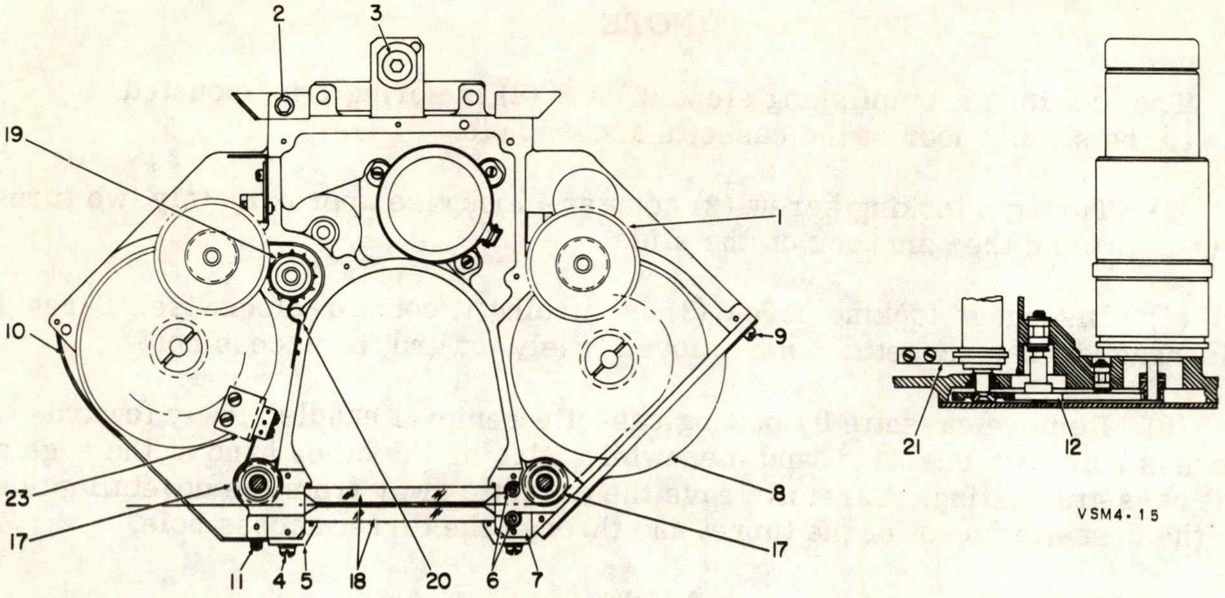
NOTE

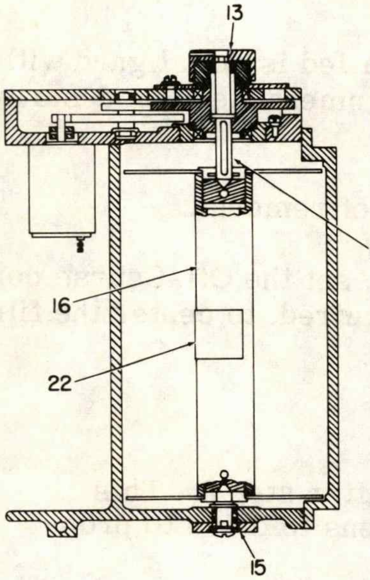
Before indexing the turret, wait 30 seconds after step 3. This will allow sufficient time for the distortion lens to drive to proper position.

CAUTION

1. Prior to operation, ensure that the cassette removal handle has been disconnected from the cassette and returned to its storage area.

2. Turret must be loaded with the programmed amount of cassettes, as improper amount of cassettes could cause an imbalance, and thereby, affect indexing.





1. Threaded Cassette Handle Mounts
2. Bib Locking Screw
3. Locking Screw
4. Film Gate Fasteners
5. Front Keepers
6. Manifold Screws
7. Manifold
8. Side Cover
9. Side Cover Screws
10. Muffler Cover
11. Muffler Cover Fasteners
12. Spline Gear
13. Plunger Knobs
14. Plunger Shafts
15. Centering Shafts
16. Spool Assembly
17. Guide roller Flanges
18. Film Gate
19. Sprocket
20. Film Guide (Top View)
21. Film Guide (Side View)
22. Film Clip
23. Microswitch

Figure 4-15. Mission Film Cassette Assembly

3. A cassette should not be installed in the turret without film.

4. Direction of film drive should not be reversed until a reverse signal has first been provided to the tensioning motor.

4-84. Removal and Installation of the Film Gate. (See figure 4-15.)

a. Removal.

(1) Remove the ten screws (4).

(2) Remove the front keepers (5).

(3) Loosen manifold (7) by turning manifold screws (6) counterclockwise until film gates can be removed.

b. Installation. Installation procedures are the reverse of removal however, the ten screws holding the front keepers in place must be tightened with a torque wrench to within 40 - 48 in. oz., in order to attain a .020 in. gap between the facing surfaces of the two glass plates of the film gate.

4-85. Removal and Installation of Cassette Film, Turret I. (See figure 4-15.)

a. Removal.

(1) Take off side cover (8) by removing the side cover screws (9).

(2) Take off muffler cover assembly (10) by removing the cover fasteners, consisting of screw, plain washer, and lockwasher (11).

(3) Disengage spline gear (12) between motor and sprocket by depressing the gear with a screwdriver inserted through access hole in cover. Sprocket should be turning freely.

(4) Advance the film toward the spool containing the most film, until all the film is on that spool.

(5) Loosen plunger knobs (13) until plunger shafts (14) can be lifted and disengaged from spools.

(6) Lift film spools to clear centering shafts (15), and draw bottom toward opening.

(7) Remove spools by gently pulling straight toward the opening.

b. Installation.

(1) Using an X-ACTO knife or similar tool, trim leading end of film 1/2 inch in from both sides and four inches back from the end, so leading end will be four inches wide. Both trims should be square cut. (See figure 4-16, below.)

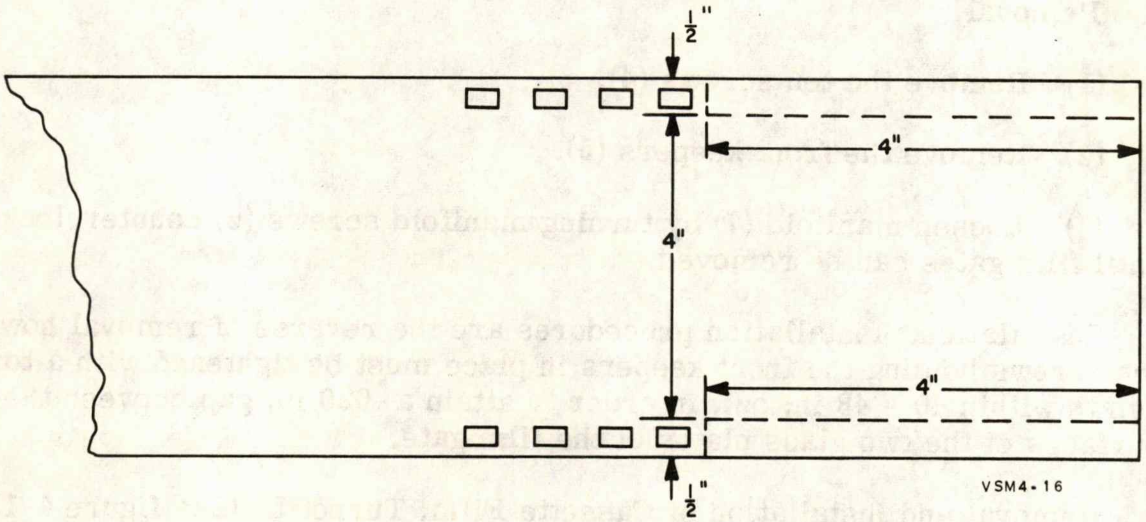


Figure 4-16. Film Trim Example

(2) Install spool assembly (16) into the compartment normally covered by the side cover (49), fitting the bottom of the spool over the guide pin (12). Allow for three feet of film leader for threading.

(3) Turn the plunger knob (13) clockwise to seat keying pin into the spool, and continue to turn, until the knob is fully seated.

(4) Compress the spring-loaded flanges of the guide rollers (17). Film can now be inserted over the rollers and between the film gates (18). The emulsion side of the film must be facing in toward the arched cavity in the cassette casting. Ensure that the spring-loaded flanges of the guide rollers are on the outside edge of the film.

(5) Pass the trimmed film leader around center portion of the sprocket (19).

(6) Advancing the trimmed film leader forward, carefully engage the film perforations (evenly aligned, top and bottom) with the sprocket teeth, ensuring that film is properly threaded through sprocket guide springs (20) and (21). Sprocket must be disengaged from spline gear. (See step a. (3) of this section.)

(7) Wrap trimmed film leader tightly around spool for four of five turns with emulsion side facing in toward the spool and attach film clip (22).

(8) Set the roller of the zero set microswitch (23) on the edge of the film so the edge rides in the groove of the roller.

(9) Install the spool in the compartment with the bottom of the spool fitting over the guide pin (15).

(10) Repeat step (3) for the second plunger knob.

(11) Replace cover (10) and secure with fasteners (11), screw, plain washer, and lockwasher.

(12) Replace cover (8) and secure with side cover screws (9). Ensure that these screws are fully tightened.

(13) Allow gear (12) to snap back and mesh with gear train.

4-86. Removal and Installation of Cassette Film, Turret II. (See figure 4-15.)

a. Removal. Procedure is the same as in Turret I (4-85a.)

(1) Remove cover (8) and associated hardware (9).

(2) Remove cover (10) and associated hardware (11).

(3) Turn plunger knobs (13) counterclockwise, until the plunger shafts (15) in both film storage compartments can be raised.

(4) Trim leading end of film 1/2 inch in from both sides and four inches back from the end, so leading end will be four inches wide. Both trims should be square cut (see figure 4-16).

(5) Disengage spline gear (12) between motor and sprocket by depressing the gear with a screwdriver inserted through access hole in cover. Sprocket (19) should be turning freely.

(6) Pass the trimmed film leader around center portion of the sprocket with the emulsion side of film facing out away from the sprocket.

(7) Advancing the trimmed film leader forward, carefully engage the film perforations with the sprocket teeth, ensuring that film is properly threaded through the sprocket guide springs (20) and (21), top and bottom.

(8) Install the loaded film spool into the film storage compartment which is enclosed by the muffler cover (10), fitting the bottom of the spool over the guide pin (15).

(9) Turn the plunger knob clockwise to seat keying pin (14) into the spool, and continue to turn until the knob is fully seated.

(10) Compress the spring-loaded flanges of the guide rollers (17). Film can be inserted over the rollers and between the film gates (18). Ensure that the spring-loaded flanges are on the outside edge of the film.

(11) Wrap trimmed film leader tightly around spool for four to five turns with emulsion side facing in toward the spool and attach film clip (22).

(12) Install the film in the film storage compartment with the bottom of the spool fitting over the guide support shaft (15).

(13) Turn the plunger knob (13) clockwise to seat keying pin (14) into the slot in the spool, and continue to turn until the knob is fully seated.

(14) Set the roller of the zero set microswitch (23) on the edge of the film, so the edge of the film rides on the groove of the roller.

(15) Replace cover (10) and secure with associated hardware.

(16) Replace cover (8) and secure with associated screws. Ensure that these screws are fully tightened.

(17) Allow gear (12) to snap back and mesh with gear train.

CAUTION

1. Film which has been spliced should not be used.

2. Illumination varifocal should not be operated at spot sizes smaller than 24 mm., when film is stationary.

3. Silver emulsion films should not be used; rather, it is recommended that dye image type film be used instead.

4-87. REMOVAL AND INSTALLATION OF THE VERTICAL RANGE RELAY. (See figure 4-17.)

a. Removal.

(1) For vertical range No. I, remove screws and side cover from the MEP frame assembly.

(2) For vertical range No. II, remove screws and front cover from the MEP frame assembly.

(3) Remove relay lens No. 1 as described in paragraph 4-82a.

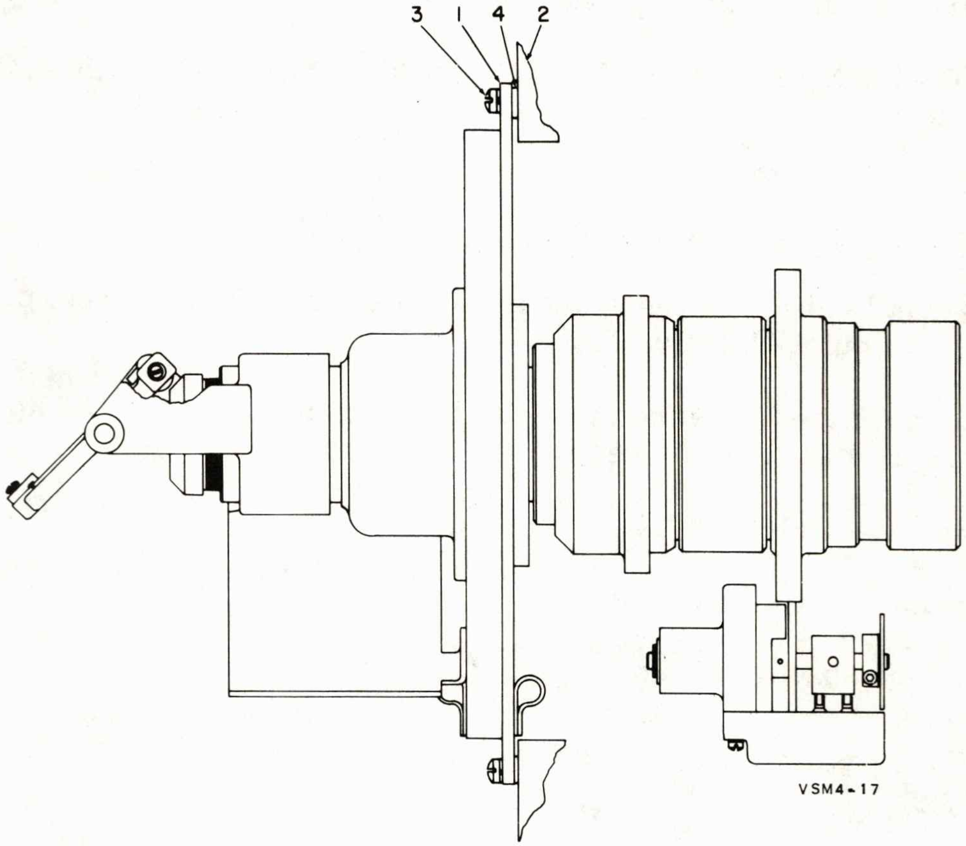
(4) Scribe vertical range lens mount (1) and its frame mount (2).

(5) Remove fasteners (3).

(6) Remove vertical range assembly.

(7) Scribe spacers (4) and frame mount.

b. Installation. Installation procedures are the reverse of removal.



1. Vertical Range Lens Mount
2. Frame Mount
3. Vertical Range Assembly Fasteners
4. Vertical Range Assembly Spacers

Figure 4-17. Vertical Range Assembly

4-88. REMOVAL AND INSTALLATION OF THE QUICK-DISSOLVE I ASSEMBLY. (See figure 4-18.)

a. Removal.

(1) Remove appropriate covers from the MEP.

(2) Remove fasteners (1).

(3) Remove the quick-dissolve assembly.

(4) Scribe spacers (2) and mounts (3).

b. Installation. Installation procedures are the reverse of removal.

4-89. REMOVAL AND INSTALLATION OF QUICK-DISSOLVE II ASSEMBLY. (See figure 4-18.)

a. Removal.

(1) Remove appropriate covers from the MEP.

(2) Visually check to see which assemblies must be removed, prior to the removal of quick-dissolve II.

(3) Remove the above mentioned assemblies according to the appropriate instructions as stated in this section.

(4) Remove fasteners (1).

(5) Remove the quick-dissolve assembly.

(6) Scribe spacers (2) and mounts (3).

1. Q-D I Fasteners
2. Spacers
3. Q-D I Mounts

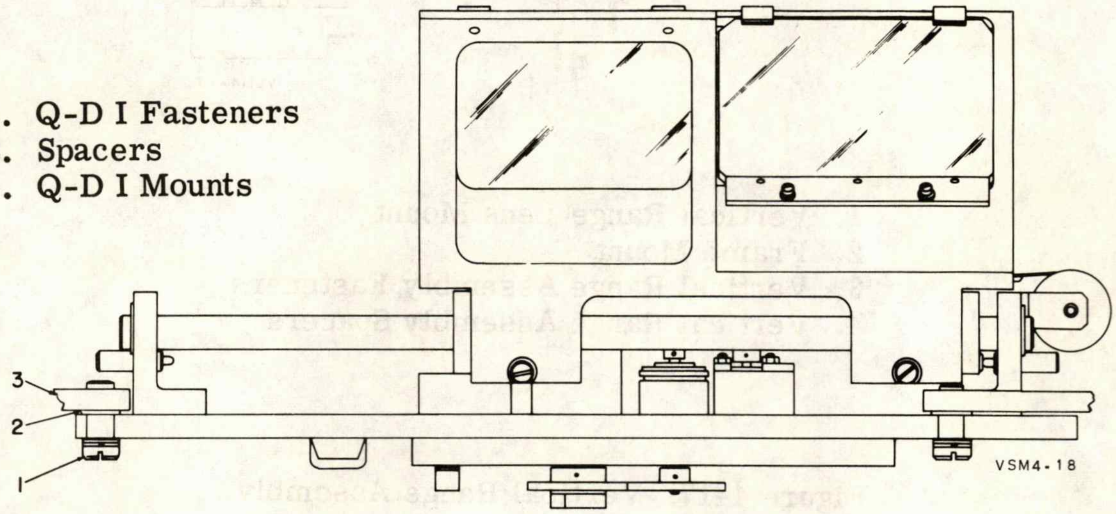


Figure 4-18. Quick Dissolve Assembly

4-90. REMOVAL AND INSTALLATION OF THE EXTENDED OFF-COURSE ASSEMBLY. (See figure 4-19.)

a. Removal.

(1) Drive the extended off-course assembly to the electrical 0 position.

(2) Remove the trans-boundary limb variation assembly as described in paragraph 4-114.

(3) Remove fasteners (1).

(4) Lift the extended off-course assembly off dowels (2) and remove.

b. Installation. Installation procedures for this assembly are the reverse of removal.

c. Calibration.

4-91. Removal and Installation of the Fixed Mirror Assembly. (See figure 4-19.)

CAUTION

1. Care should be taken to avoid the loss of shims.

2. Manual movement of the fixed mirror should never be attempted.

a. Removal.

(1) Remove the four sets of fasteners, consisting of screw, plain washer, and lockwasher (3).

(2) Remove the fixed mirror assembly.

(3) Fasten shims (4) to mounts as described in paragraph 4-65.

b. Installation. Installation procedures are the reverse of removal.

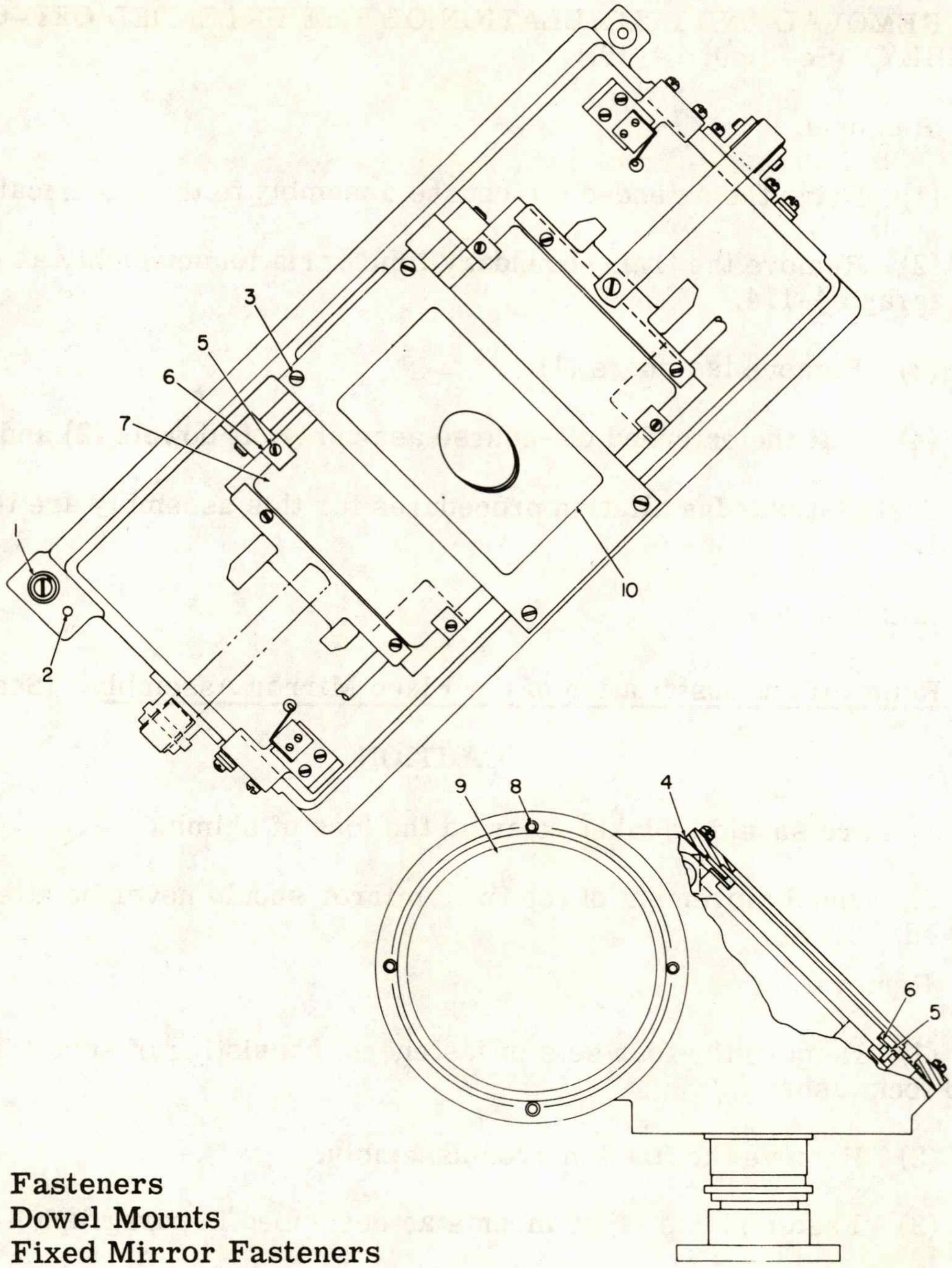
4-92. Removal and Installation of the Moveable Ring Mirror Assembly. (See figure 4-19.)

a. Removal.

(1) Remove screws (5).

(2) Remove keepers (6).

(3) Remove freed moveable ring mirror (7) with a suction cup.



1. Fasteners
2. Dowel Mounts
3. Fixed Mirror Fasteners
4. Shims
5. Moveable Ring Mirror Screws
6. Moveable Ring Mirror Keepers
7. Moveable Ring Mirror
8. Relay No. 2 Lens Screws
9. Relay No. 2 Lens

Figure 4-19. Extended Range Off-Course Assembly

b. Installation. Installation procedures are the reverse of removal.

NOTE

Due to optical alignment, the horizon mask should not be removed from this assembly.

4-93. REMOVAL AND INSTALLATION OF THE RELAY NO. 2 LENS ASSEMBLIES. (See figure 4-19.)

a. Removal.

(1) Remove the extended off-course assembly as stated in paragraph 4-90.

(2) Remove screws (8).

(3) Remove relay No. 2 lenses (9).

b. Installation. Installation procedures are the reverse of removal.

4-94. REMOVAL AND INSTALLATION OF THE ATTITUDE ASSEMBLY. (See figure 4-20.)

a. Removal.

(1) Remove fasteners for attitude assembly, consisting of screw, plain washer, and lockwasher (1).

(2) Attitude assembly, and earth blanking and collimator lens assemblies may now be simultaneously removed.

(3) Scribe spacers (2) and mount (3).

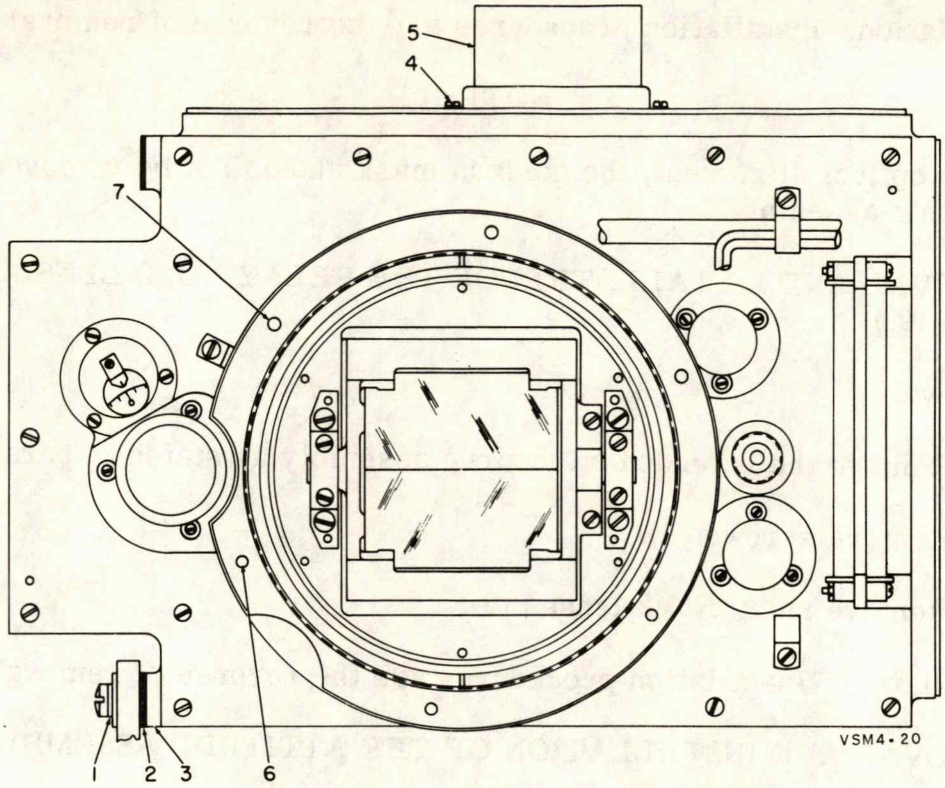
b. Installation. Installation procedures for this assembly are the reverse of removal.

4-95. Removal and Installation of the Attitude Assembly Collimator Lens. (See figure 4-20.)

a. Removal.

(1) Remove fasteners (4).

(2) Remove collimator lens assembly (5).



1. Attitude Assembly Fasteners
2. Spacers
3. Attitude Assembly Mounts
4. Collimater Lens Fasteners
5. Collimater Lens Assembly
6. Earth Blanking Assembly Screws
7. Dowel Mounts

Figure 4-20. Attitude Assembly

b. Installation. Installation procedures for the Collimator Lens Assembly is the reverse of removal.

NOTE

Collimator Lens Assembly should not be disassembled and should be replaced, as required, by a complete, new assembly.

4-96. REMOVAL AND INSTALLATION OF THE TERMINATOR AND TERMINATOR ROTATOR ASSEMBLY. (See figure 4-21.)

a. Removal.

(1) Remove attitude and earth blanking assemblies as described in paragraph 4-86a.

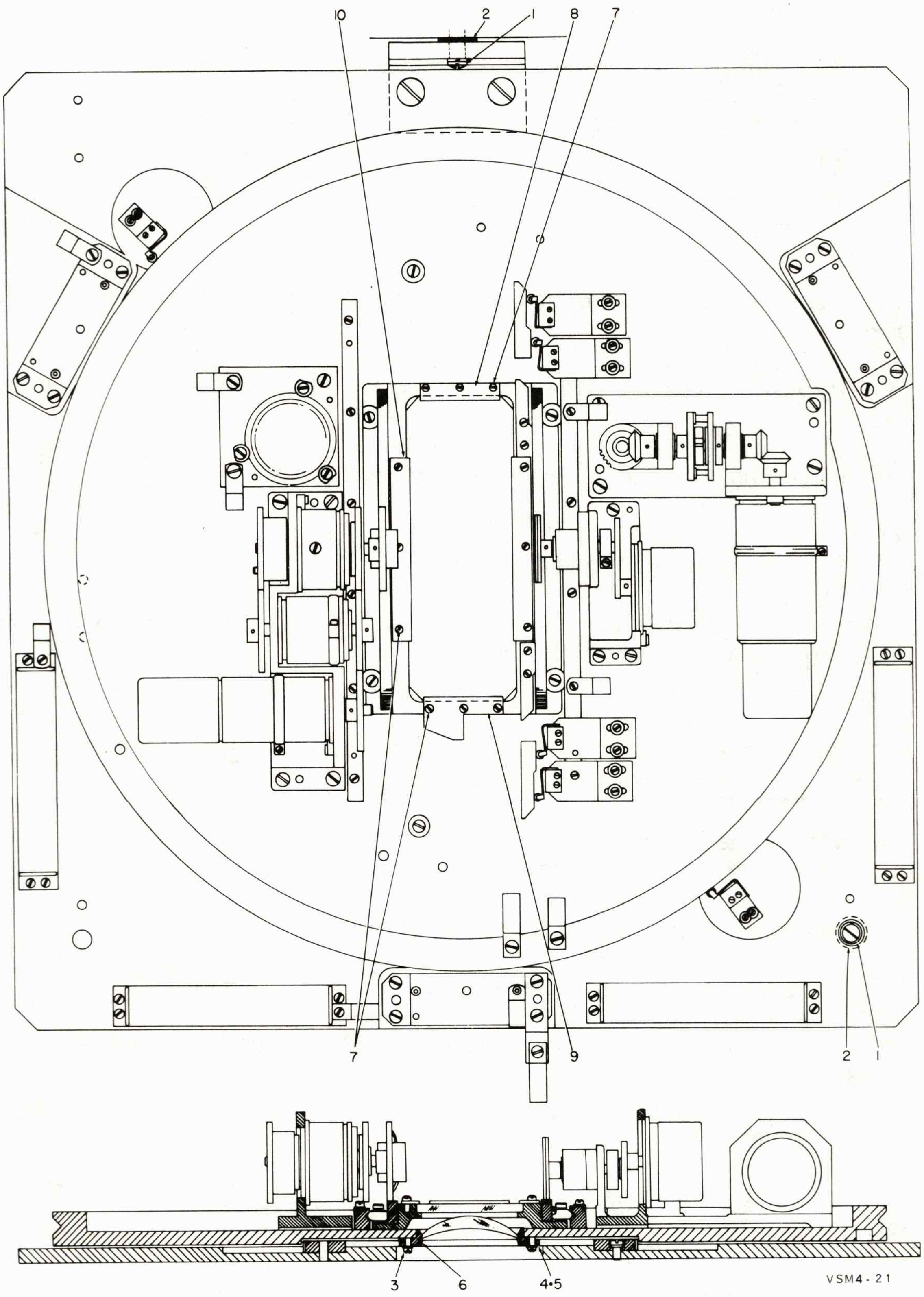


Figure 4-21. Terminator and Terminator Rotator Assembly

Reference List for Figure 4-21

1. Mounting Fasteners
2. Mounting Spacer
3. Lens Assembly Fasteners
4. Adapter
5. Shim
6. Retainer
7. Plate Screws
8. End Keeper
9. Counterweight Spring Bracket
10. Terminator Plate Keeper

(2) Remove the Trans-Boundary Limb Variation Assembly as described in paragraph 4-114a.

(3) Remove fasteners consisting of screw, plain washer, and split lockwasher (1).

(4) Carefully slip the assembly off its dowel pin alignment mountings and remove.

(5) Scribe spacers (2) and mounts.

b. Installation. Installation procedures for the Terminator and Terminator Rotor Assembly are the reverse of removal.

4-97. Removal and Installation of the Terminator and Terminator Rotator Meniscus Lens Assembly. (See figure 4-21.)

a. Removal. The Terminator and Terminator Rotator Assembly should be bench mounted for these procedures.

(1) Remove screws and lockwashers (3).

(2) Remove adapter (4) from its pilot dowel and attach shim (70).

(3) With the rest of the assembly placed on the bench, unscrew the retainer (6).

(4) Remove the lens with a suction cup.

b. Installation. Installation procedures for the Meniscus Lens are the reverse of removal.

4-98. Removal and Installation of the Terminator Focal Plane Plate. (See figure 4-21.)

a. Removal.

(1) Remove screws (7).

(2) Remove end keeper (8), counterweight spring bracket (9), and terminator plate keeper (10).

(3) Remove Terminator Focal Plane Plate (9).

b. Installation. Installation procedures for the Terminator Focal Plane Plate are the reverse of removal. Aluminized side of the plate must be positioned to face away from the Meniscus Lens (71).

4-99. REMOVAL AND INSTALLATION OF THE EARTH BLANKING ASSEMBLY. (See figure 4-20.)

a. Removal.

(1) Remove Attitude Assembly as described in paragraph 4-94a.

(2) Remove screws (6).

(3) Lift the earth blanking assembly off dowel pins (7) and remove.

b. Installation. Installation procedures of the Earth Blanking Assembly is the reverse of removal.

4-100. REMOVAL AND INSTALLATION OF THE SOLAR IMAGE ASSEMBLY. (See figure 4-22.)

a. Removal.

(1) Remove six fasteners consisting of screw, plain washer, and split lockwasher (1).

(2) Pull assembly free from the two alignment dowels (2) and remove from the MEP.

b. Installation. Installation procedures for the Solar Image Assembly are the reverse of removal.

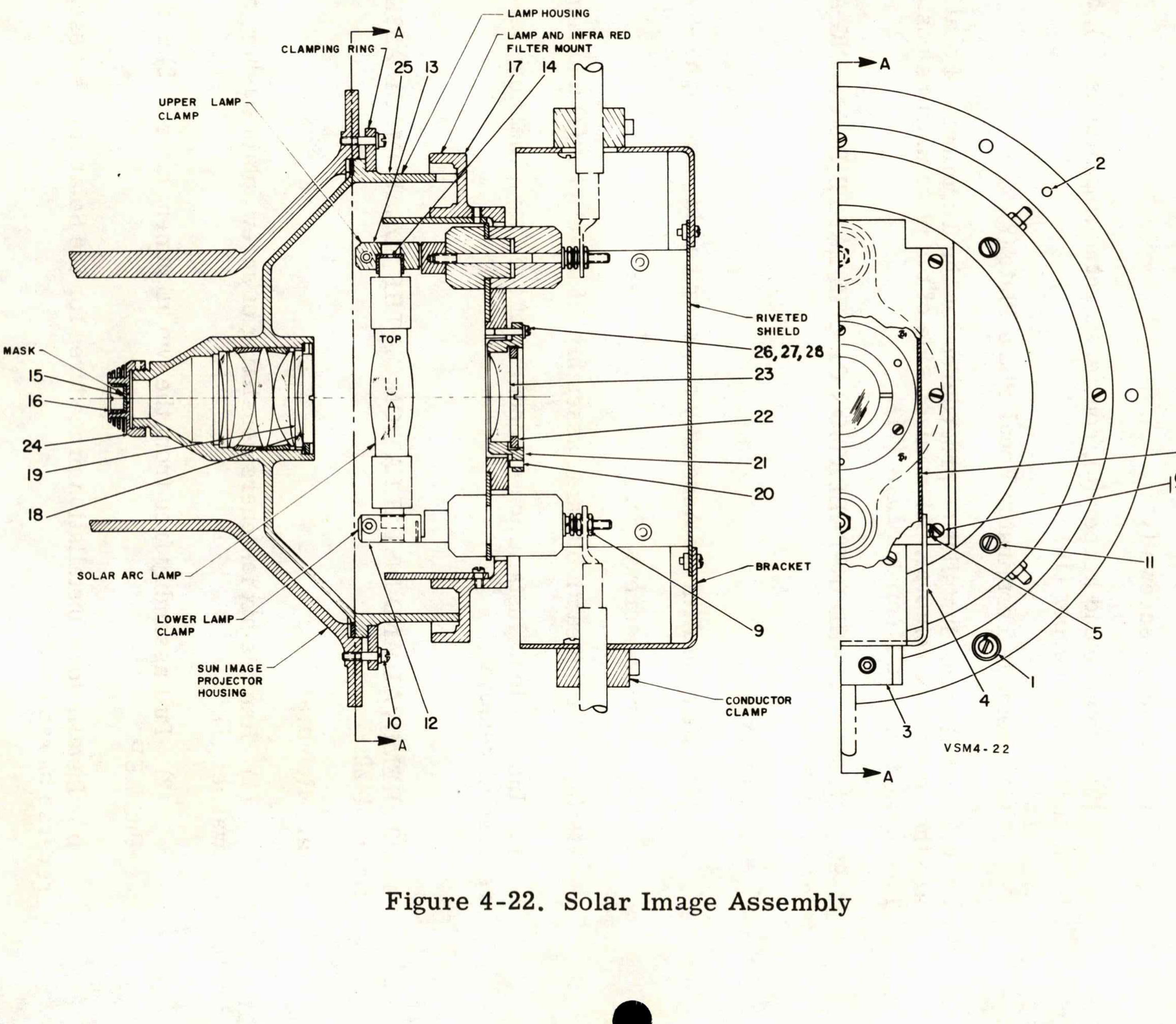


Figure 4-22. Solar Image Assembly

Reference List for Figure 4-22

1. Solar Image Assembly Fasteners
2. Dowel Mount
3. Clamp Assembly
4. Bracket
5. Bracket Screws
6. Screws
7. Lockwasher
8. Riveted Shield
9. Electrode Nut
10. Lamp Assembly Fasteners
11. Lamp Mount Fasteners
12. Lower Clamp
13. Upper Clamp
14. Arc Lamp
15. Mask
16. Mask Retainer
17. Mount
18. Retaining Ring
19. Negative Lens
20. Set Screw
21. Set Screw
22. Mirror Retainer
23. Condensing Mirror
24. Field Stop Housing
25. Lamp Housing
26. Washer
27. Screw
28. Lockwasher

4-101. Removal and Installation of the Solar Image Lamp Housing Assembly. (See figure 4-22.)

a. Removal.

(1) Loosen and take apart clamp assembly (3).

(2) Loosen bracket (4) by removing screws (5).

(3) Remove screws (6) and lockwasher (7).

(4) Remove riveted shield assembly (8).

(5) Remove nuts (9).

(6) Disconnect wires from terminals on lamp.

(7) Remove screws and lockwashers (10).

(8) Lift lamp housing and condenser sub-assemblies carefully away from the main assembly.

b. Installation. Installation procedures of the lamp housing are the reverse of removal.

4-102. Removal and Installation of the Solar Image Assembly, Arc Lamp. (See figure 4-22.)

WARNING

Whenever ignited lamp is exposed, Baush and Lomb, Ray Ban protective goggles, Type Z-301E, must be worn. Protective gloves must also be worn.

a. Removal.

(1) Remove power from the arc lamp.

WARNING

Due to internal pressure of the lamp, allow a cooling period of 45 minutes for the lamp.

(2) Remove and disassemble the lamp housing as described in paragraph 4-101a.

(3) Disconnect leads to both anode (+) and cathode (-) terminals by removing the outer hex nut (9) only.

(4) Remove screws, plain washers, and lockwashers (11), four each, that secure the lamp mount to lamp housing.

(5) Remove lamp mount and its attached components to service area.

(6) Loosen upper (13) and lower (12) clamp assemblies.

(7) Remove the lamp and put the guard cover on it.

b. Installation.

(1) Install lamp with anode electrode (+) containing cap (14), being inserted into the top clamp (13).

(2) Tighten the lower electrode clamp (-) until the lamp is secured.

(3) Tighten the upper electrode clamp (+) to a snug fit only, to allow for expansion.

(4) The rest of installation procedures for the arc lamp are the reverse of removal.

(5) Calibration. Check mirror reflection and focus of arc electrodes at the mask (15).

4-103. Removal and Installation of the Solar Image Field Stop Assembly. (See figure 4-22.)

a. Removal.

(1) Remove the retainer (16) by unscrewing it.

(2) Remove the mask (15).

b. Installation. Installation of the field mask is the reverse of removal.

4-104. Removal and Installation of the Solar Image, Negative Lens Assembly. (See figure 4-22.)

NOTE

It is not necessary to remove the entire solar image assembly from the MEP.

a. Removal.

(1) Remove fasteners consisting of screw, plain washer, and lockwasher (11).

(2) Carefully lift and remove mount for lamp and infra-red filter (17) and all attached components.

(3) Unscrew retaining ring (18) and remove.

(4) Lift negative lens (19) from housing with a suction cup.

b. Installation.

(1) Install the lens with the surface of greatest curvature (smaller radius) facing toward the lamp.

(2) The remaining installation procedures for the negative lens are the reverse of removal.

NOTE

When installing the lamp assembly, care should be taken to ensure that the electrodes of the arc lamp are properly positioned, with respect to polarity.

4-105. Removal and Installation for the Solar Image Condensing Mirror Assembly. (See figure 4-22.)

a. Removal.

(1) Remove and disassemble lamp housing as stated in 4-101a.

NOTE

Settings on set screw (20) and mirror cell (21) should not be disturbed.

(2) Turn retainer (22) counterclockwise until free of mirror cell and remove.

(3) Remove condensing mirror (23) with a suction cup.

b. Installation. Installation procedures for the condensing lens are the reverse of removal.

4-106. REMOVAL AND INSTALLATION OF THE TRANS-BOUNDARY FILM LAMP ASSEMBLY. (See figure 4-13.) Removal and installation procedures for the Transboundary Film Lamp Assembly are exactly the same as given for the Mission Film Lamp Assembly described in paragraph 4-66.

4-107. Removal and Installation of the Trans-Boundary Film Lamp Assembly, Arc Lamp. (See figure 4-13.) Removal and installation procedures for the arc lamp are exactly the same as given for the Mission Film Lamp Assembly Arc Lamp described in paragraph 4-66.

4-108. REMOVAL AND INSTALLATION OF THE TRANS-BOUNDARY ILLUMINATION ASSEMBLY. (See figure 4-23.)

a. Removal.

(1) Remove fasteners consisting of screw, plain washer, and lockwasher (1).

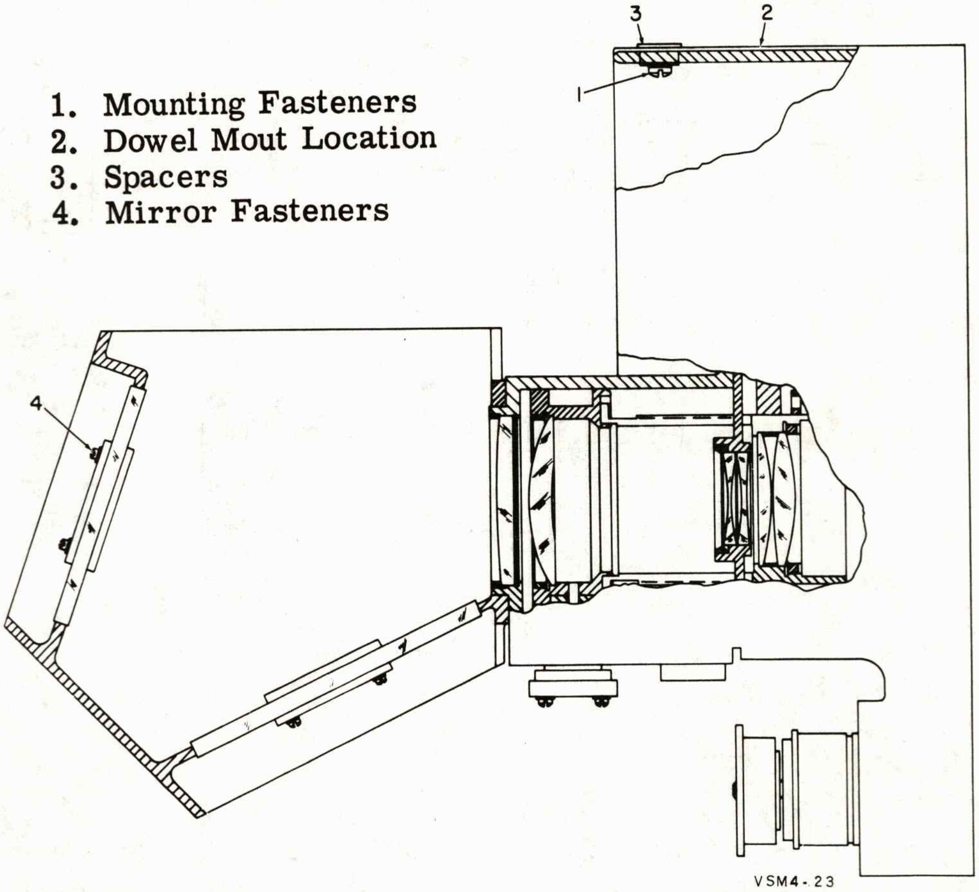
(2) Lift the assembly carefully off its dowel pin mounting (2) and remove.

(3) Scribe spacers (3) and mounts.

4-109. Removal and Installation of the Trans-Boundary Illumination, Condenser Relay Mirror Assemblies. (See figure 4-23.)

a. Removal.

(1) Remove machine screws and split lockwashers (4).



1. Mounting Fasteners
2. Dowel Mout Location
3. Spacers
4. Mirror Fasteners

Figure 4-23. Transboundary Illumination Assembly

(2) Lift mirrors free from assembly and remove.

b. Installation. Installation procedures for the condenser relay mirrors are the reverse of the removal.

4-110. REMOVAL AND INSTALLATION OF THE TRANS-BOUNDARY CASSETTE. (See figure 4-24.)

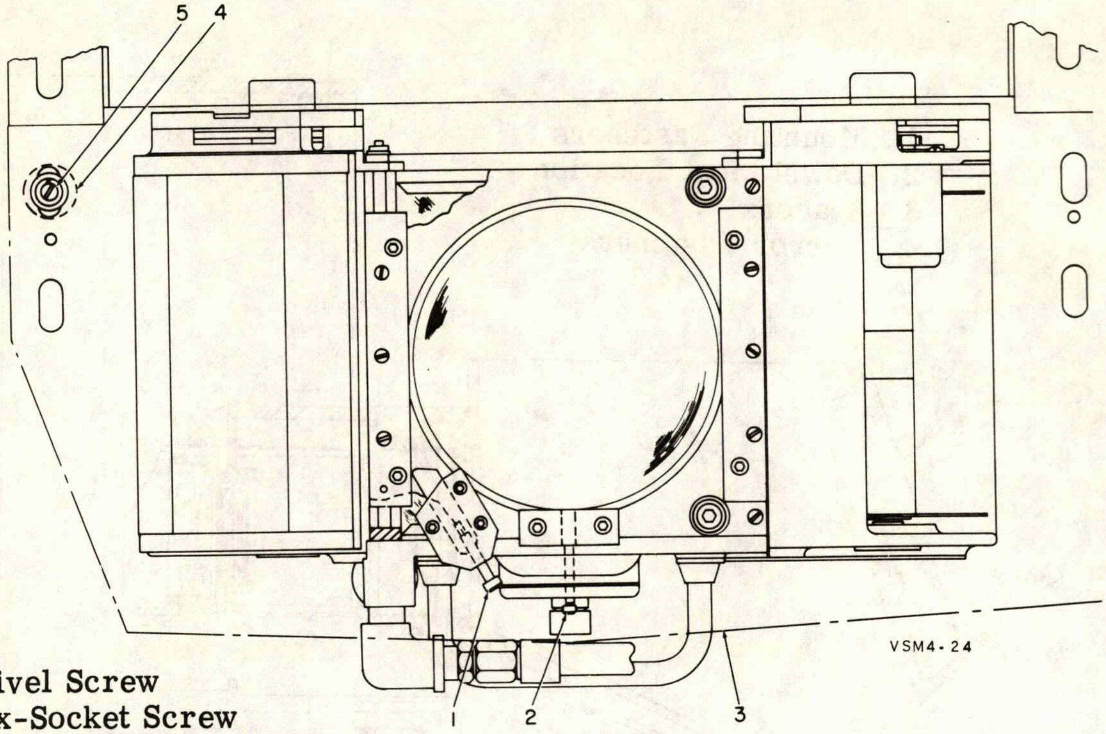
a. Removal.

(1) Remove screws and the lamp support structure side cover.

(2) Loosen swivel screw (1).

(3) Loosen hex-socket screw (2) until cassette can move freely along the dovetail mount.

(4) Placing one hand on the permanent cassette handle (3) and the other hand on the cassette casing, gently guide the cassette off its mount and out through the hole provided when step (1) was performed.



1. Swivel Screw
2. Hex-Socket Screw
3. Cassette Handle
4. Mounting Fasteners
5. Spacers

Figure 4-24. Transboundary Cassette and Cassette Rotator Assembly

b. Installation. Installation procedures are the reverse of removal.

4-111. Removal and Installation of the Trans-Boundary Cassette Film. (See figure 4-25.)

a. Removal. Film removal procedures for the trans-boundary cassette are the same as procedures for the turret film cassettes, paragraph 4-85a.

b. Installation.

(1) Trim leading end of film with X-Acto knife or similar tool to ensure a clean-cut edge. (See figure 4-16.)

(2) Install the spool assembly into the compartment normally covered by the side cover (1), fitting the bottom of the spool over the guide pin. Allow for three feet of film leader for threading.

(3) Turn the plunger knob (2) clockwise to seat the keying pin into the spool, and continue to turn, until the knob is fully seated.

(4) Compress the spring-loaded flanges of the guide rollers (3). Film can now be inserted over the rollers and between the film guides (4). The emulsion side of the film must be facing in toward the center of the cassette.

1. Side Cover
2. Plunger Knob
3. Guide Rollers
4. Film Guides
5. Sprocket
6. Sprocket Guide Springs
7. Microswitch

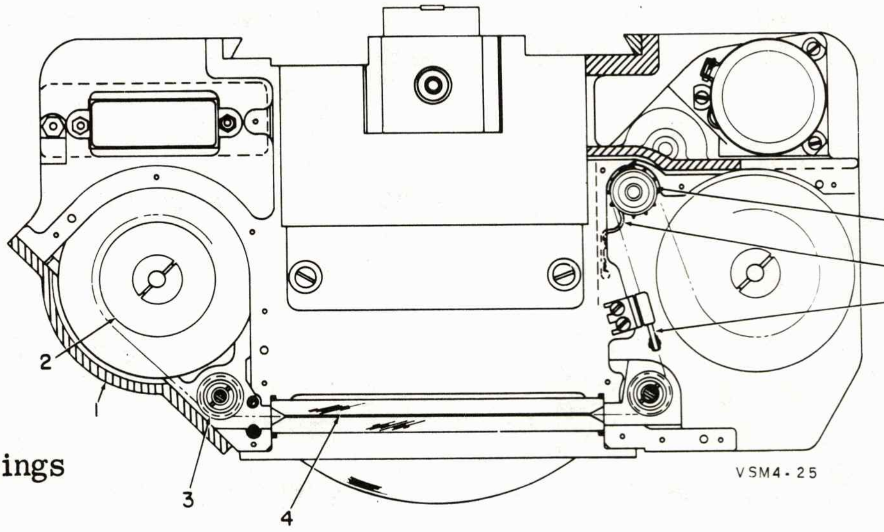


Figure 4-25. Transboundary Cassette Assembly

(5) Release the flanges, ensuring that they are on the outside edge of the film.

(6) Pass the trimmed film leader around center portion of the sprocket (5).

(7) Advancing the trimmed film leader forward, carefully engage the film perforations (evenly aligned, top and bottom) with the sprocket teeth, ensuring that the film is properly threaded through the sprocket guide springs (6) top and bottom. The sprocket must be disengaged from the spline gear.

(8) Wrap the trimmed film leader tightly around the empty spool for four to five, turns with the emulsion side facing in towards the spool.

(9) Set the roller of the zero set microswitch (7) on the edge of the film of the groove of the roller rides on the edge of the film.

(10) Install the spool in its compartment with the bottom of the spool fitting over the guide pin.

(11) Repeat step (3) for the second plunger knob.

(12) Replace the side cover and its associated fasteners.

(13) Replace the muffler cover and its associated fasteners.

(14) Allow the spline gear to snap back and mesh with the gear train.

4-112. REMOVAL AND INSTALLATION OF THE TRANS-BOUNDARY CASSETTE ROTATOR ASSEMBLY. (See figure 4-24.)

a. Removal.

(1) Remove the trans-boundary cassette (refer to paragraph 4-102a).

(2) Scribe spacers (4) and mount.

(3) Remove fasteners (5).

(4) Remove the cassette rotator.

b. Installation. Installation procedures for the rotator are the reverse of removal.

4-113. REMOVAL AND INSTALLATION OF THE TRANS-BOUNDARY VERTICAL RANGE AND BLANKING ASSEMBLY. (See figure 4-26.)

a. Removal.

(1) Remove fasteners (1).

(2) Remove the vertical range and blanking assembly.

b. Installation. Installation procedures are the reverse of removal.

4-114. REMOVAL AND INSTALLATION OF THE TRANS-BOUNDARY LIMB VARIATION ASSEMBLY. (See figure 4-27.)

a. Removal.

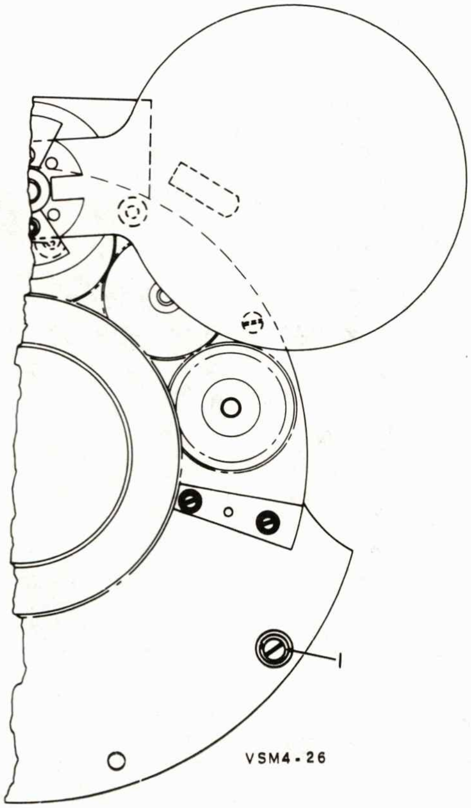
(1) Remove the fasteners (1).

(2) Gently ease the assembly off the dowel pins (2) and remove it.

b. Installation. Installation is the reverse procedure of removal.

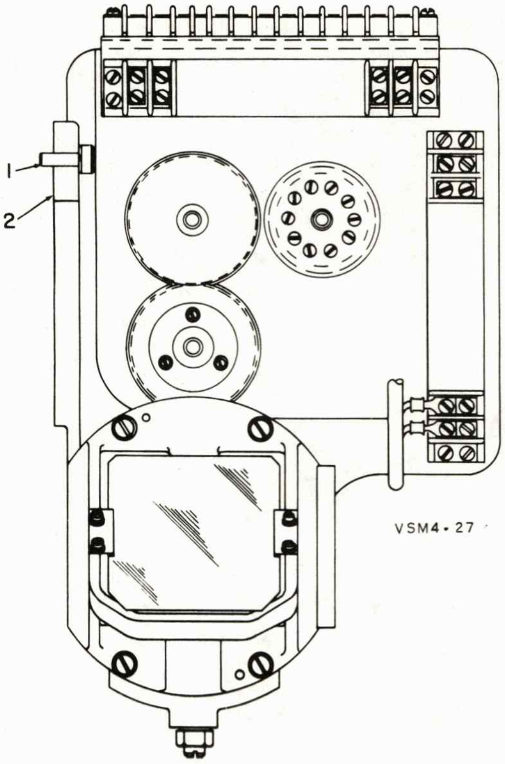
NOTE

The horizon mask should not be removed from this assembly.



1. Mounting Fasteners

Figure 4-26. Vertical Range and Blanking Assembly



1. Mounting Fasteners
2. Dowel Mount

Figure 4-27. Limb Variation Assembly

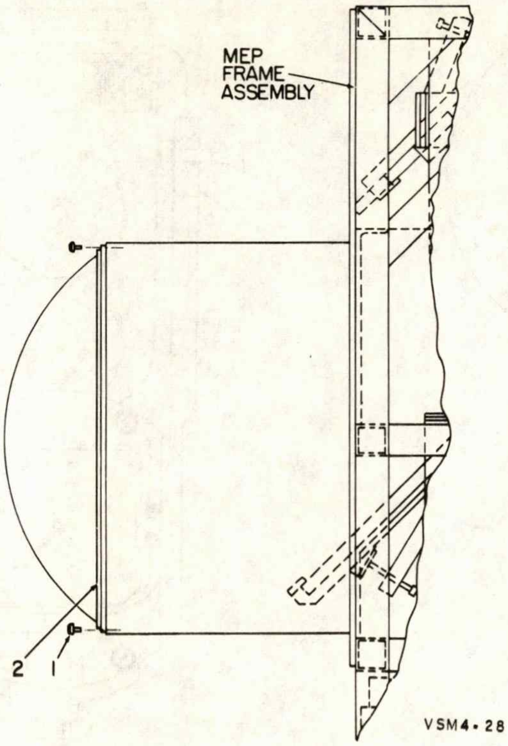
4-115. REMOVAL AND INSTALLATION FOR THE PROJECTION SCREEN ASSEMBLY. (See figure 4-28.)

a. Removal.

(1) Remove fasteners (1).

(2) Lift support framework and screen assembly (2) free from locating dowels.

b. Installation. Installation procedures for the Projection Screen Assembly are the reverse of removal.



1. Mounting Screws
2. Mounting Frame

Figure 4-28. Projection Screen Assembly

4-116. OUT-THE-WINDOW DISPLAYS POWER SUPPLIES.

4-117. The three types of power supplies in the out the window displays are removable as follows:

4-118. Mission Film Power Supply. Removal of the mission film power supply requires no special tools and is a straightforward operation. The following sequence of steps is provided as a check list to insure that each operation is accomplished.

a. Shut-down power to equipment.

b. Remove plug-in connector P2 from connector J2 at the rear of the power supply.

c. Remove plug-in connector P3 from connector J3 at the rear of the power supply.

d. Remove the eight screws on the front of the panel holding the power supply in position.

e. Slide the power supply out of the cabinet.

4-119. Trans-Boundary Power Supply. Removal of the trans-boundary power supply requires no special tools and is a straightforward operation. The following sequence of steps is provided as a check list to insure that each operation is accomplished.

a. Shut-down power to equipment.

b. Remove plug-in connector P2 from connector J2 at the rear of the power supply.

c. Remove plug-in connector P3 from connector J3 at the rear of the power supply.

d. Remove the eight screws on the front of the panel holding the power supply in position.

e. Slide the power supply out of the cabinet.

4-120. 400-Watt Solar Power Supply. Removal of the solar effects power supply requires no special tools and is a straightforward operation. The following sequence of steps is provided as a check list to insure that each operation is accomplished.

a. Shut-down power to the equipment.

b. Remove plug-in connector P2 from connector J3 at the rear of the power supply.

c. Remove the eight screws on the front of the panel holding the power supply in position.

d. Slide the power supply out of the cabinet.

4-121. RENDEZVOUS AND DOCKING.

4-122. IMAGE GENERATION EQUIPMENT. The equipment used in the rendezvous image generation equipment, in most cases, is easily removed and installed. Standard procedures for removal are used throughout, using standard tools. In cases where a particular assembly or subassembly requires a unique or unfamiliar procedure for removal, a step-by-step process is given. Where the installation of a unit differs from the reverse of removal, specific additional steps are included.

4-123. Vidicon Tube. Since the alignment for the vidicon tubes is critical, care should be taken during removal and installation.

NOTE

Never turn the vidicon face down. Any dirt or material in the tube will "spot" the photo surface.

4-124. To remove the vidicon, the camera cover should first be removed, and then the lens mount unscrewed and removed. (This is the large, knurled, threaded mount housing the lens.) Loosen the two hex, socket-head screws on the split clamp which holds the vidicon's position in the tube, at the rear of the vidicon.

NOTE

Do not loosen the screws holding the tube socket. The socket acts as an alignment for the vidicon.

Remove the vidicon by sliding it out through the front of the unit.

4-125. Installing the vidicon is the reverse of the removal but for two possible exceptions. The socket mounting may have to be slightly rotated in order to seat the tube. This is due to the close tolerance of the pin holes in the tube socket. Extreme care should be taken during this operation. Also, when seating the vidicon, the short pin on the vidicon should be inserted in the pin socket with the red dot on the side of the socket. This will ensure power hook-up of the vidicon.

NOTE

Push the vidicon in the tube housing as far as it will go. Constant pressure must be kept on the vidicon while tightening the split clamp so as to ensure no axial play. This is to ensure that the vidicon will remain in the focal plane of the lens system.

4-126. Projector Assemblies. Prior to the removal of the assemblies, make sure that power to cabinet seven is completely removed. Check all power supplies associated with cabinet seven to be sure switches are in the "off" position.

NOTE

The projector assemblies are critically aligned, therefore, the removal of this unit should be done with some degree of caution.

4-127. Since removal of this assembly is critical and difficult to handle, two men are required to successfully remove the assembly. No special tools are needed. Removal of both assemblies is similar except for one noted distinction in order to remove the front projector assembly, the rear one must also be removed. For each assembly the following procedures should be used:

a. Remove connectors (J2 through J14) from the rear of both camera control assemblies.

b. Remove the power connector located at the rear of the projector.

c. Remove the two power leads (TB1-1 and TB1-2) from the rear of the projector.

d. Remove the four top binding screws of the projector assembly connecting the support plate to the shock springs on the shelf bracket.

e. Remove the assembly from the cabinet.

CAUTION

Do not remove the projector from the support plate. This is critically aligned to the camera.

4-128. Vidicon Camera Tube. Removal of the vidicon camera tube is accomplished as follows:

a. Remove three screws holding the light shield at the front of the camera.

b. Disassemble the lens plate and lens from the camera by removing the three screws on the lens plate.

c. Remove the camera cover.

CAUTION

Avoid damaging the vidicon camera tube when removing the tube socket.

d. Once the camera cover is removed, remove the vidicon tube socket by pulling back gently and rocking the tube socket.

e. Remove the slotted locking ring at the front of the camera with a spanner wrench.

f. Measure the distance between the faceplate of the tube and the front of tube mount. Record this measurement for the replacement procedure.

g. Loosen the knurled ring at the rear of the tube mount.

CAUTION

Make certain there are no flared edges at the base of the vidicon camera tube. If flared edges are present, remove the knurled ring and nylon inner ring before removing the vidicon camera tube.

h. Slide the vidicon camera tube forward and out of the camera.

4-129. Installation of the vidicon camera tube is accomplished using the following procedures:

a. Slide the vidicon camera tube into the tube mount until the distance between the faceplate and tube mount is equal to the value recorded, in paragraph 4-128f.

b. Orient the vidicon camera tube so that, when looking into the lens, the large space (keyway) is centered at the left.

c. Hand tighten the knurled ring at the rear of the vidicon camera tube.

d. Replace the slotted ring at the front of the camera and use the spanner wrench to tighten.

e. Reconnect the tube socket at the rear of the vidicon camera tube by applying a gentle rocking action.

f. If necessary, clean the faceplate of the vidicon camera tube and lens.

g. Reassemble the lens and lens-plate to camera.

h. Reassemble the light shield.

4-130. <u>TV Monitor.</u> Removal of the TV monitor is accomplished as follows:

NOTE

Be certain that power to unit 7 is removed and that no power is present in the cabinet.

a. Remove the power cable from the female socket located on the middle post of unit 7.

b. Unhook the coaxial cables from the back of the TV monitor.

c. Unscrew the face plate of the monitor using the four hand screws located in each corner.

d. Unscrew the monitor from the cabinet.

e. The monitor may now be removed.

f. Installation is the reverse of removal.

CAUTION

Care must be taken not to strike the picture tube neck or face.

4-131. Cathode Ray Tube. Removal of the cathode ray tube is accomplished as follows:

a. Check to ensure that all power to the CRT is off.

b. Remove the high voltage anode connection (located on the side of the CRT).

c. Ground the high voltage anode to ensure all change is dissipated.

NOTE

The CRT is mechanically very unstable. Use extreme caution while working on the tube. Do not handle the tube unnecessarily. A safety shield which covers the whole face should be worn by anyone working around the area during this operation.

d. Remove the CRT tube socket.

e. Fasten the tube extractor to the CRT frame.

f. Fasten the CRT to the tube extractor.

g. Loosen the CRT from the fiber cone by removing the 12 screws.

h. Manually remove the CRT by means of the extractor. Be sure that the CRT is not contacting the coils circling the neck.

NOTE

Electrical realignment may be necessary when a new CRT is installed. If the old CRT is reinstalled, electrical realignment should not be necessary.
When installing the CRT, use the extractor for this purpose. This device will also ensure proper positioning.

4-132. Model Servo System Three-Stage Follow-Up Potentiometers. When removing and installing the three stage follow-up potentiometers from the Zeta, Eta, Xi and sun rotational servos, extreme caution must be observed at all times. The terminal of this component cannot tolerate any form of physical abuse such as bumping, torsion, or pulling on wires attached to them. The described method of attaching wires to the potentiometer should be adhered to. Under no circumstance should a soldering iron be employed to attach wires as this will result in burn out of the component.

SECTION V

REPAIR INSTRUCTIONS

5-1. GENERAL.

5-2. Repair of the visual system equipment is minimized, due to the large number of sealed unit type assemblies. Instructions for the repair of assemblies which do not fall in this category are included in this section under the appropriate heading. Although there are other possible methods of repair to some assemblies, the procedure given should be followed to ensure effective repair.

5-3. TELESCOPE AND SEXTANT REPAIR.

5-4. Repair instructions for the telescope, sextant, and associated equipment is limited, due to the sealed unit type structure of the equipment. Other than minor malfunctions, the various assemblies must be replaced as complete units, and the defective part returned to the manufacturer for repair.

5-5. TELESCOPE.

5-6. On-site repair operations for the rotating reticle assembly and the C/M occulting assembly are covered in separate paragraphs. No repair or replacement of either of the above assemblies is possible without removal of the complete reticle occulting and lens assembly from the telescope. In this connection, attention is again called to the CAUTIONS in Section IV regarding the necessity to minimize the possible entrance of dust, or other foreign material, into the interior of the instrument.

5-7. REPLACEMENT OF DEFECTIVE ROTATING RETICLE ASSEMBLY. Each of the rotating components, both electrical and mechanically - matched bearing assemblies are individually fitted to the stationary housing and rotating barrel of a particular rotating reticle assembly. For this reason, and because of the extremely rigid dust-free and thermally controlled conditions that must be obtained during the assembly, internal repairs to the rotating reticle are not practical as an on-site repair operation. Removal of a defective assembly and the installation of a replacement assembly is described in Section IV. Installation of a replacement rotating reticle assembly must be followed by electrical zeroing of the pancake resolver; refer to Section VI for this procedure.

5-8. Following the reassembly of the reticle, occulting, and lens assembly to the telescope, connect the interconnecting cables W542 and W543 to connectors 13J1 and 13J2, respectively. Energize the electronic cabinets (units 9 and 10) and proceed as follows:

a. Energize the MEP and present the test pattern frame for viewing.

b. Set the telescope reticle rotation servo test resolver, on the test panel of unit No. 9, to zero rotation.

c. Establish simulated zero roll of the MEP test pattern.

d. Observe the test pattern image on the reticle through the eyepiece and, if necessary, orient the X and Y axes of the engraved reticle with the X and Y axes of the test pattern. By loosening the clamps that secure the reticle mounting plate, rotate the cover until the corresponding axes index; tighten the cover clamps. Scribe new zero markings on cover plate and casting, and paint over or otherwise eliminate the original marks.

e. Perform the functional tests for the rotating reticle as described in Section II.

5-9. The miniature incandescent edge-lighting lamps, installed in the rotating reticle assembly (see figure 5-1), have a minimum required life of 4000 hours at 6 volts a-c. In the event of failure of one lamp, the replacement of all four lamps is recommended to maintain uniformity of usage. The procedure is as follows:

a. Remove the rotating reticle, assembled to its mounting plate. (Refer to Section IV.)

CAUTION

Protect the surface of the engraved reticle by taping barrier material over the cylindrical openings on the front and back of the assembly.

b. Remove four no. 2-56 x 1/4 inch cap screws and no. 2 split lockwashers and retaining straps that secure the edge lighting lamps to the end plate. Remove the retaining straps from the lamps.

c. Remove the shrink-type insulating sleeving on the leads of each of the four lamps and disconnect the soldered splices of the integral lamp leads to the leads from terminal board 13TB3. Cut the leads of four replacement lamps, strip insulation, and resolder connections as indicated. Install new lengths of shrink-type shielding and, by the application of heat, shrink the shielding so that it will fit in the grooves of the endplate.

d. Install retaining straps over the lamps and secure the straps to the endplate with the previously removed cap screws and lockwashers.

NOTE

In securing the retaining clamps, make sure the filament of each lamp extends 0.016 inch beyond the edge of the indenture in the endplate.

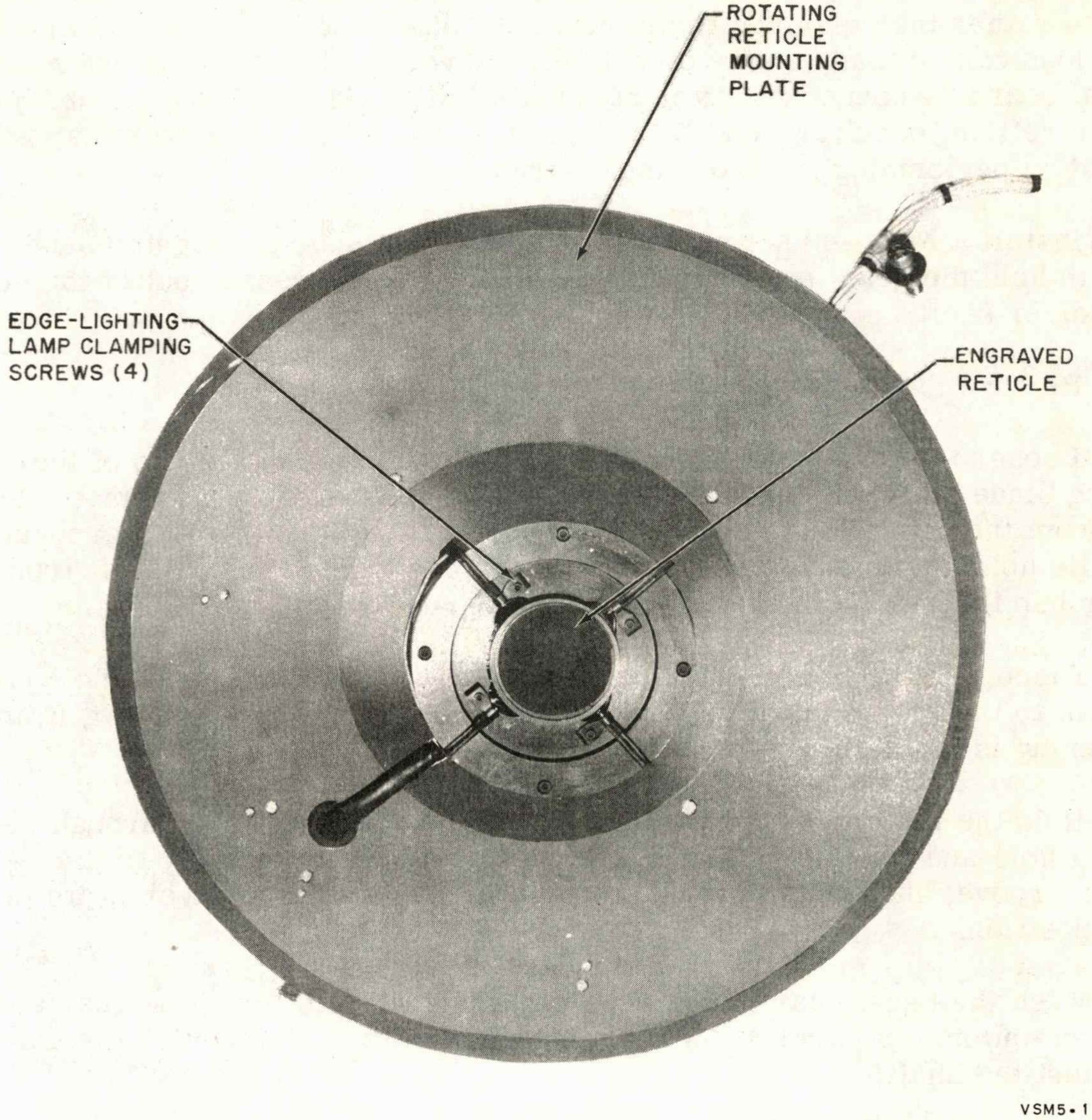


Figure 5-1. Rotating Reticle Assembly, Rear View

e. Connect cable W542 to connector 13J1 on the reticle, occulting, and lens assembly; energize the power control panel, and test the reticle illumination by turning the RETICLE INTENSITY rheostat through the complete range. If all four lamps respond correctly, deenergize the power control panel and disconnect cable assembly W542.

f. In reassembling the rotating reticle and mounting plate to the reticle, occulting, and lens assembly, following replacement of illumination lamps, check that the inscribed resolver electrical zero marks on the cover plate and the casting are indexed before tightening the cover plate clamps.

g. Reassemble the reticle, occulting the lens assembly to the telescope. (Refer to Section IV.)

5-10. RESOLVER REPLACEMENT. The bevel gear, driven by a resolver, is pinned rather than clamped to the resolver shaft, and the electrical disconnections can be made on the defective resolver itself, thus eliminating terminal board disconnects. After removal of the C/M occulting assembly from the reticle, occulting, and lens assembly, a defective resolver may be replaced by performing the following instructions.

a. Install a No. 4-40 set screw in the bevel gear hub and tighten sufficiently to hold the gear in place when the spring pin is pressed out of the hub and resolver shaft.

b. Remove the spring pin.

c. Loosen the three standard synchro clamps on the underside of the occulting blade plate. Loosen the gear hub set screw, but do not remove the screw from the hub. Rotate the synchro clamps out of the resolver groove and, while holding the bevel gear in place, withdraw the resolver shaft from the gear hub through the mounting hole in the plate.

d. Disconnect the electrical leads from the defective resolver and connect them to the replacement resolver, making sure the corresponding R and S numbering is maintained.

e. Hold the bevel gear in hand and insert the resolver shaft through the mounting hole and into the gear hub. Rotate the synchro clamps into the resolver groove, and tighten the clamp screws to hold the resolver in its installed position.

f. Mesh the bevel gear on the resolver shaft with its matching gear and, when the minimum of backlash is achieved, tighten the set screw in the gear hub against the shaft.

CAUTION

> During the next procedure, do not attempt to use the original spring pin hole in the gear hub as a pilot for drilling a spring hole in the resolver shaft. Drill a new hole.

g. Using a 1/16 inch drill, match drill the gear hub and resolver shaft and insert a new spring pin. When the gear hub and shaft are pinned, remove the No. 4-40 set screw from the gear hub.

h. Connect cable assembly W542 to connector 13J1, energize the electronics cabinet (unit no. 9), and establish electrical zero for the newly installed resolver. When the resolver has been zeroed, check out the operation of the occulting blade in accordance with functional test procedures in Section II. Assuming affirmative results are obtained, perform the last two procedures for the motor-generator/gearhead replacement.

5-11. C/M OCCULTING ASSEMBLY. As in the case of the rotating reticle assembly, repairs to the C/M occulting assembly require removal of the assembly from the reticle, occulting, and lens assembly, following the removal of the main assembly from the telescope. Instructions for removal of the occulting unit are described in paragraph 4-14.

5-12. Recommended on-site repair of the C/M occulting assembly is limited to the replacement of a defective motor-generator/gearhead assembly, or a resolver, assuming a malfunction of occulting blade movement has been traced to the component of the occulting unit. In the event the occulting assembly malfunction is mechanical, worn or stripped gears, worn or seized bearings, etc., the complete occulting assembly must be replaced as a unit and the defective assembly returned to the manufacturer for repair.

5-13. MOTOR-GENERATOR/GEARHEAD REPLACEMENT. (See figure 5-2.) Replacement of the motor-generator gearhead is accomplished as follows:

a. Refer to tables 3-2 and 3-3 and disconnect the motor and tachometer leads from terminal board 13TB4, 13TB5, or 13TB6, depending on which motor-generator is being replaced. Pull the leads through the hole in the occulting unit mounting plate.

b. Loosen the screw in the split hub clamp, so that the motor shaft can later be withdrawn from the bevel gear.

c. Loosen the three standard synchro mounting clamps on the underside of the plate, and rotate the clamps out of the groove in the gear head. Hold the motor-generator/gearhead in place during this operation, to prevent damage to the bevel gear.

d. Keeping the bevel gear meshed with its matching gear, carefully withdraw the motor shaft from the split hub clamp which was loosened in the above step. Retighten the clamp screw just sufficiently to hold the clamp on the gear hub, until the replacement motor is installed.

e. Insert the shaft of the replacement motor-generator/gearhead upward through the hole in the occulting blade plate and loosen the gear hub clamp screw enough to install the bevel gear and clamp on the shaft.

f. Position the gearhead so that the synchro clamps can be rotated into the mounting groove and tighten the clamp screws.

g. Mesh the bevel gears and position the bevel gear on the motor shaft so that there is a minimum of backlash. Tighten the split gear hub clamping screw.

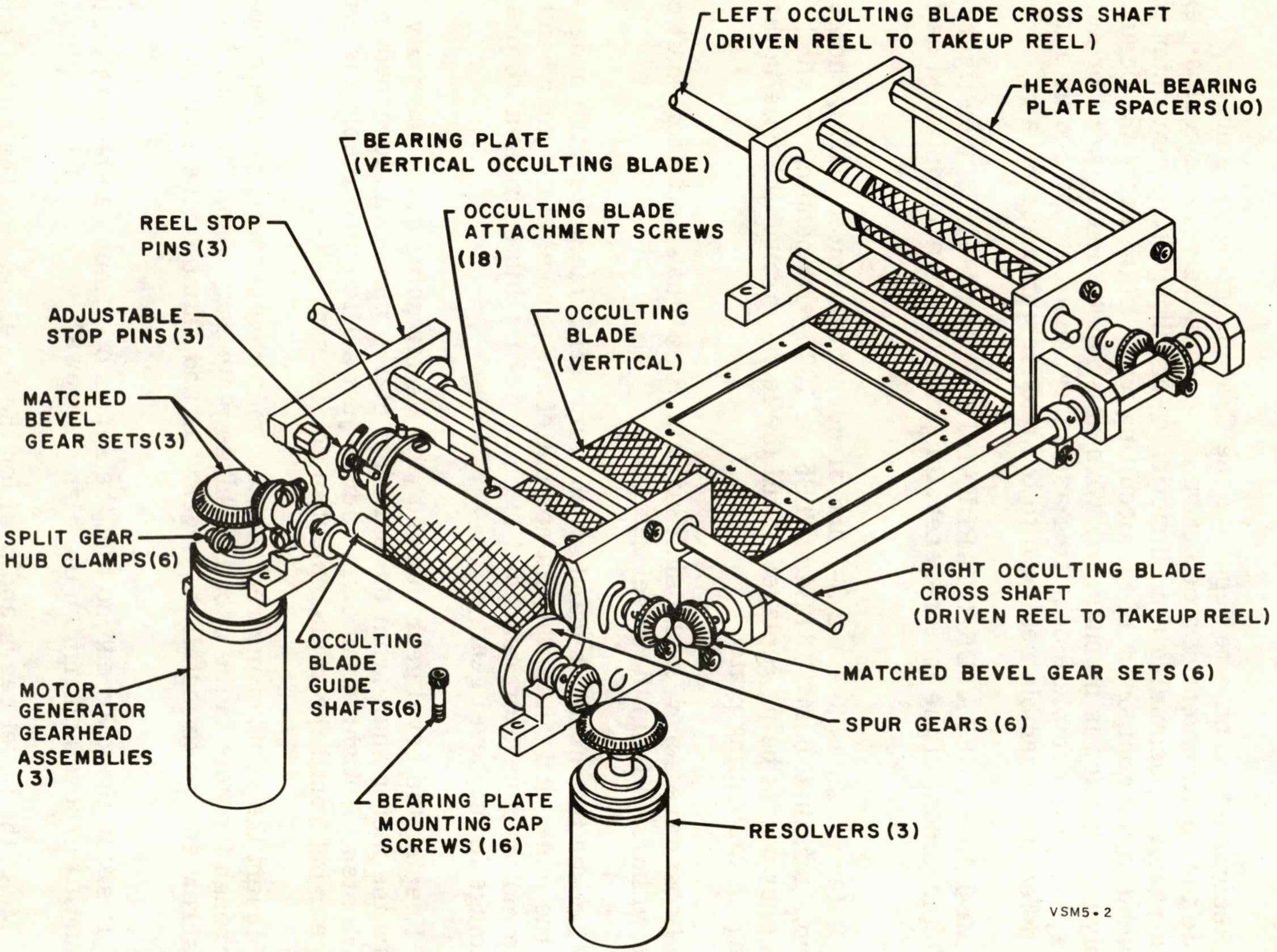


Figure 5-2. Occulting Blade Mechanism (Typical)

h. Thread the motor and the tachometer leads through the hole in the occulting assembly mounting plate. Place identification markers on the leads corresponding to the leads of the replaced motor-generator, and make connections to the terminal boards 13TB4, 13TB5, or 13TB6.

i. Reconnect cable assembly W542 to connector 13J1; energize the electronics cabinet (unit 9); and, by means of the appropriate test resolver, check out the operation of the newly installed motor-generator, in accordance with the functional test (Refer to Section II). Assuming affirmative results are obtained, deenergize the electronics cabinet; disconnect connector 13J1; reassemble the occulting assembly; and reassemble the complete unit on the telescope.

j. Following reassembly, reenergize the electronics cabinet and conduct the functional tests recommended in Section II.

5-14. SEXTANT.

5-15. Site repairs to the operable assemblies of the sextant are limited to the following:

a. Rotating reticle edge light replacement.

b. Landmark and starfield Alpha and Beta servo motors and resolvers replacement.

c. Starfield generator servo resolvers replacement.

d. Carousel motor-generator and resolver replacement.

e. Slide actuator Slosyn motor replacement.

f. Variable magnification motor-generator, gearhead and resolver replacement.

g. Rotating polaroid filter drive motor and resolver.

h. Replacement of limit switches in the rhomb scanning, variable magnification, and landmark slide actuator assemblies.

CAUTION

Prior to the removal of a subassembly, either on or off the optical bed plate, place a protective device, such as polyethelene film or a piece of sheet metal, underneath the piece to be removed to protect elements below from falling articles that might be dropped.

The mechanical elements of the operable assemblies, because of the extremely close tolerances in gearing backlash, bearing end-play, etc., are individually fitted to the assembly housings. For this reason, a malfunction caused by mechanical defect that significantly affects sextant performance, necessitates the replacement of the defective assembly and its return to the manufacturer for repair. This statement also applies to an electrical failure of the pancake-type in either the rotating reticle's or the rotating prism's pancake-type motor, resolver, or transformer coupling.

5-16. POST-REPAIR OPERATIONS. Following the replacement of a subassembly (motor, resolver, or switch), when the assembly is not removed from the optical bed plate, the functional tests described in Section II must be performed, prior to returning the sextant to "normal" operation. When the repair operation involves the replacement or removal of a major assembly, the alignment procedures described in Section VI must be performed prior to the functional tests.

5-17. RETICLE EDGE-LIGHTING LAMP REPLACEMENT. The reticle illumination lamps must be replaced after ten 350-hour operating periods. In the event of individual lamp failure, prior to that time, a determination must be made whether or not the remaining lamps provide sufficient illumination to continue operation until the required replacement time. If the determination is negative, all four lamps must be replaced. Replacement lamps are assembled into a repair part item called "insert, light assembly."

a. Remove the rotating prism and eyepiece tube support weldment. (Refer to paragraph 4-42.)

b. Disconnect the edge light leads at terminal board 12TB3. (See figure 4-9.) Record the connections for each individual lamp insert.

c. Inscribe a mark on the reticle housing, annularly, at the front surface of the reticle holder clamping ring; also inscribe a mark on the reticle housing, axially, on the clamping ring, and ensure that the two marks match. These marks are for reference in positioning the reticle assembly both axially and at the established electrical zero after replacement of the light insert assemblies.

d. Remove the two light insert assemblies, accessible from above; replace with new assemblies, and mark the leads of the replacement inserts to correspond with those removed.

e. Loosen the clamping rings of the reticle assembly holder sufficiently to permit rotation of the assembly; repeat procedure d. for the remaining two insert assemblies.

f. Reposition the reticle assembly in the holder clamping rings, using the scribe marks made in procedure c. as references, and tighten the clamping rings. Connect the light insert leads to terminal board 12TB3 as per recorded notes made in procedure b.

g. Perform alignment and positioning procedures for rotating reticle assembly replacement. (Refer to Section VI.) Make any required adjustments.

h. Re-install the rotating prism and eyepiece tube support weldment. Perform the functional tests described in Section II, after the sextant is mounted in the supporting structure.

5-18. SERVO COMPONENT REPLACEMENT. The majority of the standard servo components in the sextant are replaceable without removing the affected assembly. The principal exceptions are the starfield scanner Alpha rhomb motor and 32X resolver, the starfield Beta rhomb 1X resolver, and the starfield generator starfield rotation resolver. The landmark scanner, Alpha rhomb motor, and 32X resolvers are made accessible by removing the spacer plate on which terminal board 12TB6 is mounted. The replacement of motors and/or resolvers is relatively straightforward and should present no major problems for a trained technician experienced in working with servo systems. The following paragraphs are intended as guide lines and precautions to be observed during the replacements.

5-19. Resolver Replacement. Electrical disconnection at the resolver taps will usually be easier than disconnection at the terminal boards, since the unlacing of the wire bundles will not be necessary. Before disconnecting however, ensure that each lead is identified correctly for rotor or stator. Refer to the electronics cabinet information for zeroing instructions, following installation of the replacement resolver.

5-20. Carousel Motor-Generator Replacement. Removal of the carousel rotation motor necessarily involves removing the drive pinion from the gear train. Before removing the pinion from the defective motor shaft, carefully and accurately measure and record the position of the pinion on the shaft. After driving out the dowel pin and removing the pinion from the removed motor shaft, use the dimension thus recorded to position the pinion on the replacement motor shaft, prior to match drilling the pinion hub and motor shaft for installation of a new dowel pin. Drill the new dowel pin hole on the hub at approximately 90 degrees from the old hole.

5-21. Starfield Generator Starfield Selector Drive Motor Resolver. Removal of this resolver is facilitated by moving the starfield scanner Alpha rhomb sector gear arm to the limit of travel toward the telescope in order to make the electrical disconnections on the resolver. Access to the coupling hub clamp is obtained through the holes in the adapter on which the resolver is mounted.

5-22. Starfield Generator Starfield Rotation Drive Motor Resolver. Prior removal of the combined light source assembly is required in order to replace this resolver. As noted in paragraph 4-43 following the initial removal of the combined light source in the sextant unit at MCC-H and in the sextant at MCC-K, the combined light source assembly will be removable without first removing the entire sextant from the supporting structure.

5-23. Rhomb Scanners' Two-Speed Servos. The landmark Alpha rhomb drive motor with the attached 32X resolver and the Beta rhomb 1X resolver are accessible for removal, with the scanner assembly in place on the optical bed plate, by first removing the top spacer plate. However, since the spacer plate is doweled to the side plates in the starfield scanner, the scanner assembly must be removed from the bed plate to gain access to the starfield Alpha rhomb motor, 32X resolver, and the Beta rhomb 1X resolver. The replacement of the Beta rhomb motors, 32X resolvers and the Alpha rhomb 1X resolvers in both scanner assemblies can be made without disturbing the mountings on the bed plate.

5-24. Rhomb Scanner Motor Replacement. The Alpha rhomb and Beta rhomb drive motors in both landmark and starfield rhomb scanner assemblies are removed by removing the mounting plates to which they are attached.

CAUTION

> In order to prevent the gear train between the motor pinion and the rhomb sector gear from coming out of the assembly with the mounting plate, lash the first idler spur gear to the scanner end plate.

a. Disconnect the drive motor leads at the applicable terminal boards and remove the leads from the laced wire bundles.

b. Disconnect the 32X resolver leads from the resolver taps.

NOTE

> The 32X Alpha rhomb resolvers are more easily disconnected at the applicable terminal board.

c. Remove the six 1/4 inch socket head cap screws securing the motor mounting plate to the spacers; the spacers are vertical in the landmark rhomb scanner, and horizontal in the starfield rhomb scanner.

d. Carefully separate the mounting plate from the spacers, making sure the four dowel pins remain in the spacers, and pull the drive motor straight back until the motor pinion is disengaged from the idler gear. If the idler gear shaft bearing remains on the shaft, remove it from the shaft and replace it in the mounting plate.

e. Refer to paragraph 5-20, and follow the sample procedures for remove of the pinion from the defective motor shaft and installation on the replacement motor shaft.

f. Remove the defective motor from the mounting plate; install the replacement motor on the plate. If the 32X resolver is functioning properly, remove it from the defective motor and install it on the new motor. If both motor and resolver are defective, install a replacement resolver. Install the replacement drive motor by reversing the above procedures. Zero the d-c servo loop and perform the required functional tests described in Section II of this manual.

5-25. Rhomb Scanner 1X Resolvers. All four 1X resolvers are most easily removed by removing the two socket head cap screws that secure the resolver support to the scanner end plates. The supports are doweled to the end plates; consequently, adequate care must be exercised when separating the support from the end plate. After removal, the spur gear hub clamp is loosened and the gear removed before removing the defective resolver from the support. When replacing the assembled new resolver, spur gear, and resolver support, leave the gear hub clamp untightened until after alignment of the gear with the sector gear pinion.

5-26. Rhomb Scanner 32X Resolvers. Removal and replacement of the Alpha rhomb 32X resolvers are essentially covered in the instructions for removal of the rhomb scanner drive motors; removal of the Beta rhomb 32X resolvers is obvious.

5-27. Slide Actuator Slosyn Motor. To replace the Slosyn motor in the slide actuator assembly, the side plate of the assembly on which the motor is mounted is removed from the assembly. The plate is fastened to the three hexagonal spacers by 1/4 inch socket head cap screws.

CAUTION

> Provide support for the two cross shafts in the assembly before removing the end plate; the shaft end bearings are held in the plate by retainers, and will come off with the plate.

When the end plate is removed from the assembly, remove the gear from the motor shaft, thus making the three countersunk motor mounting cap screws accessible. Install the replacement motor on the end plate and, after reassembly of the plate to the actuator mechanism, install and clamp the gear on the motor shaft.

5-28. Variable Magnification Servo. Replacement operations of the motor-generator/gearhead and resolver in the variable magnification assembly are straightforward and require little elaboration. Adapters are provided for both, with access holes for loosening the coupling hub clamps.

5-29. Rotating Polaroid Drive Motor and Resolver. The rotating polaroid filter is driven, through gearing, by the same drive motor that is used in the starfield generator. The motor mounting plate opening is large enough to permit withdrawal of the drive gear with the motor. Replacement procedures for either component require no elaboration.

5-30. Limit Switches. Replacement of defective limit switches on the telescope side of the starfield rhomb scanner requires prior removal of the scanner assembly from the optical bed plate. Count-outs in the side plate of the variable magnification assembly provide access to the mounting screws of the limit switches at either end.

5-31. STORAGE. A defective operable assembly, or fixed optical component, determined to be non-repairable at the using site and which is to be returned to the manufacturer for repair or replacement must be prepared for pre-shipment storage in accordance with Military Specification MIL-P-116D, Method IIf. Optical glass surfaces shall first be covered with a minimum of six thicknesses of lens cleaning tissue, firmly attached in place with pressure sensitive tape. The assembly or unit shall be placed in a heat sealed plastic bag along with desiccant, conforming to MIL-D-3464, using Formula I, to determine quantity of desiccant.

CAUTION

> No preservative coatings shall be applied to any surface of the item.

Resilient dunnage, in sufficient quantity to protect the item from damage during shipment, shall completely surround the bagged item within the shipping container.

5-32. OUT-THE-WINDOW DISPLAYS REPAIR.

5-33. Repair instructions for the out-the-window display equipment is limited mainly to the electronic components. and the mechanical assemblies. Repair of the optical equipment is restricted to cleaning procedures which are covered in Section VII.

5-34. CELESTIAL SPHERE.

5-35. Repair of the celestial sphere surface is limited to painting and cleaning. If the surface of the sphere has been scratched or scarred, the following steps should be taken.

a. Thoroughly clean the marred or scratched area.

b. Retouch only the affected area with a small brush, using 3M optical black velvet paint. Care should be taken to assure that only the scratched portion be retouched.

5-36. PNEUMATIC PRESSURE TUBE.

5-37. Repair of a leak in the pneumatic tubing is accomplished as follows:

a. Stop the leak by changing fittings as required.

CAUTION

Nuts must be closed only finger tight. Use of a wrench will crush the plastic ferrule of the poly-flo tubing.

b. Set pneumatic pressure at 10.5 ±.5 psig by attaching an exhaust valve of a standard bicycle pump to valve.

c. Close valve 5 and check that all other valves are firmly closed. (See figure 1-15.)

5-38. HIGH POWER D-C AMPLIFIER - 10A2A2.

5-39. When replacing power transistors, it is important to coat the mounting surface of the heat sink with a layer of silicon grease. The silicon assures proper thermal conductivity from the transistor case to the heat sink. This procedure applies to all transistors mounted on the power amplifier assembly, two transistors mounted on the preamplifier assembly, and four power rectifiers and the SCR mounted on the chassis.

SECTION VI

CALIBRATION AND ADJUSTMENT

6-1. GENERAL.

6-2. In the visual system, precise calibration and adjustment is of primary importance to obtain the highest degree of realism for the visual presentations. Step by step procedures are given for each unit or assembly with the related checks or tests referenced when necessary.

6-3. Electronic equipment alignment as well as optical equipment alignment is of a very critical nature. Extreme care should be exercised at all times and especially when adjusting or calibrating the visual equipment and display to ensure that no foreign articles or debris comes in contact with the mirrors, lenses, contacts, etc. Strict adherence to the notes, cautions, and warnings throughout should be practiced to avoid unnecessary shut down time and damage to the equipment.

6-4. TELESCOPE/SEXTANT, AND ASSOCIATED EQUIPMENT.

6-5. Calibration and adjustment of the telescope and sextant systems is accomplished initially during installation. Following the initial assembly and installation, no mechanical adjustment is required for various assemblies as they are pinned or fastened in place and cannot be moved. Instructions included in this section are those necessary to maintain correct performance. Any adjustment to the systems should only be accomplished when a malfunction exists, and not on a periodic basis or as a routine procedure.

6-6. TELESCOPE.

6-7. Instructions for calibration and adjustment of the MEP, celestial sphere, and C/S illuminator and occulting assembly are contained under headings of the same title. Electrical adjustments, such as resolver zeroing and adjustment of reticle illumination intensity, are detailed under the telescope/sextant electronics cabinet heading. Following initial assembly and installation, no mechanical adjustment is required for the CM occulting assembly and rotating reticle assembly.

6-8. OPTICAL ALIGNMENT. Under normal circumstances the optical alignment of the telescope will be maintained during the life of the instrument. However, an accidental displacement of a mirror or (more unlikely) displacement of a lens cell during the removal and replacement of the MEP could occur, resulting in a misalignment in either the MEP or starfield lines of sight. Such a misalignment could also result from a very severe impact on the telescope frame; e.g., by a swinging crane boom, or being struck by other mobile equipment. In the first instance the fault

should be easily located, since the technician inside the telescope frame will be aware of the component with which he came in contact; however, a misalignment resulting from the second type of accident will necessarily be more difficult to localize.

6-9. An alignment technique, employed during the initial assembly and alignment of the telescope prior to preliminary acceptance testing, is described in a succeeding paragraph. This technique involves the alignment of each optical path independently, followed by the observance of the correct combination of the two lines of sight, as seen through the telescope eyepiece.

CAUTION

> It is absolutely essential that optical alignment procedures be performed only by technicians of the highest caliber who are thoroughly experienced in the handling and adjustment of precision optics.

6-10. Optical Alignment By Reflection Technique. A series of lenses in an optical system can be aligned, i.e., squared and centered, to a high degree of accuracy by observing the reflections from the optical center of each lens surface of a point source of light. This is done by holding a small, open-filament light source (pen-light or Edmunds No. 50095 grain-of-wheat light assembly) close to the pupil of the observer's eye while sighting down an optical path. Parallax between the eye pupil and the light source can be minimized if the lamp is held directly below the eye for horizontal measurement, and directly to the right or left of the eye for vertical measurement. In the use of this technique, one sighting for horizontal measurement and one sighting for vertical measurement are required in order to minimize the parallax error in the interpretation of the results.

6-11. The reflections of the light source from each of the lens surfaces can be described as analogous to sighting down a row of street lights several blocks long. First, take a sighting from just above the first light in the row (which will disclose whether one or more lights are out of line in the horizontal plane), and then from just to the right or left of the first light (which will disclose a displacement of one or more lights in the vertical plane). In this analogy, it follows that the number of street lights seen (the number of reflections) depends upon the number of elements in the optical path. Each lens will present two reflections, one from each surface. In the case of the telescope, each cell assembly consists of several lens elements, therefore a misalignment of one cell assembly will appear as a displacement of all of the light reflections in one group of the several groups being observed. This displacement can be at an angle to the rest of the reflections or parallel to the main line, but in either case the desired direct sequence will not exist. Similarly, the presence of mirrors in the optical path, again as in the case of the telescope, will not affect the illusion of a straight row

of street lights, providing all the mirrors are properly positioned. However, the angular displacement of a mirror will angularly displace all of the street lights (lens surface reflections) beyond it.

6-12. In using the above described technique, it is of first importance to isolate the faulty component when a misalignment is found to exist. This is most easily achieved by observing the alignment of sections of each optical path in turn. This method of alignment is effective in presenting a simultaneous indication of lens centering and squareness, as well as correct mirror positioning, where a hyper-critical alignment is not essential.

6-13. Pre-alignment Requirements. Two optical technicians, of the type described in the CAUTION at the end of paragraph 6-9, are required to perform optical alignment procedures. The more highly skilled of the two technicians takes the sightings from outside the telescope frame. He also directs the procedures to be performed by the second technician, inside the frame, in positioning the components required to correct the misalignment.

6-14. Equipment and Special Tools. Equipment and tools required for realignment are listed in Table 6-1.

6-15. Telescope Preparation for Alignment Check. To perform the alignment procedures described below, the reticle, occulting and lens assembly must be removed from its mounting (see Section IV). In addition, the center telescope cover panels must be removed from the front and left (sextant) sides of the frame, to permit access to the optical components.

Table 6-1. Test Equipment and Tools

Item	Name	Manufacture or Specifications
1.	Open-filament light source (pen-light)	Edmonds No. 50095 "grain-of-wheat" light assembly
2.	Prism	90°-silvered on the hypotenuse
3.	Opaque cards	Three 5 inch square
4.	Microscope	Tubular with a fixed reticle
5.	Microscope	Tubular without reticle but with a threaded adapter
6.	Surface plate	Grade B (about 4 by 6 feet)
7.	Precision height gage	

Table 6-1. Test Equipment and Tools (Cont)

Item	Name	Manufacture or Specifications
8.	Depth micrometer	
9.	Machinist's square	
10.	Steel parallels	Assorted sizes (1" square and 4, 5, 6, and 8" long)
11.	Light source	Portable 150 watt, diffusing
12.	Test fixture	Adjustable height with clamping arms
13.	Test pattern slides	One opaque with transparent lines and one transparent with opaque lines
14.	Differential voltmeter	
15.	Sine-wave generator	
16.	Video-signal generator	
17.	Shim stocks	0.001" thickness
18.	Dioptometer (with adapter)	
19.	VTVM	
20.	Test resolver	Variable speed, motor driven, mounted on a precision test stand (accuracy 1 minute, speed range 0.20 to 60 deg/sec.)
21.	Oscilloscope	Tektronixs 585 (with 2A63 d-c to 300 kc differential plug-in unit.)
22.	Water level	
23.	Fixture mounted telescope	
24.	VOM	

Table 6-1. Test Equipment and Tools (Cont)

Item	Name	Manufacture or Specifications
25.	Autotransformer (variable)	
26.	Telescope Collimator Array	Farrand Optical Company
27.	Wild Pocket Transit	Farrand Optical Company
28.	Celestial Sphere Test Fixture	Farrand Optical Company
29.	Celestial Sphere Centering Drill Fixture	Farrand Optical Company
30.	MEP Test Fixture	Farrand Optical Company
31.	Adjustable Target Fixture	Farrand Optical Company
32.	Celestial Sphere Illumination System Crosswire Target	Farrand Optical Company
33.	Celestial Sphere Illumination System Pinhole Aperture	Farrand Optical Company
34.	Telescope Reticle Illumination Transformer	Farrand Optical Company
35.	Auto-Collimating Alignment Telescope, ten power with optical square	Farrand Optical Company
36.	Tripod	With Height and two Axes Tilt Adjustment (Must sustain a weight of 50 pounds)

Table 6-1. Test Equipment and Tools (Cont)

Item	Name	Manufacture or Specifications
37.	Alignment Telescope	Link Part No. 573032
38.	Target Glass (six required)	Link Part No. 573035
39.	Target Mirror (four required)	Link Part No. 566592
40.	Alignment Fixture-Platform	Link Part No. 572890
41.	Alignment Fixture-Rail (two required)	Link Part No. 572891
42.	Centering Fixture-Sun Ring	Link Part No. 572893
43.	Alignment Fixture-Sun Ring	Link Part No. 572894
44.	Light Source-Alignment Telescope	Link Part No. 454195
45.	6" Precision Levels (three required)	Link Part No. 529449
46.	Water Level-five minute graduations (two required)	

6-16. ALIGNMENT PROCEDURES. If, as explained in paragraph 6-8, the misalignment has been caused by accidental contact with one or more components (lens cell or mirror) and the location of the component(s) is known, an adjustment of the faulty component(s) will correct the error. An alignment check by the reflection method must precede and follow adjustment. The reason for checking prior to adjustment is to approximate the amount and type of adjustment required. When the misalignment is the result of severe impact on the telescope, the faulty component(s) must be first located using the reflection technique, then adjusted. After adjusting, the corrected alignment must be rechecked before reassembly of the reticle occulting and lens assembly to the telescope.

6-17. Alignment Check by Reflection Technique. Refer to the optical schematic of the telescope (refer to Section VIII). By counting the lens element in each leg of each optical path between the cube beamsplitter and the two objectives, determine the number of reflections (street lights) to be seen in each leg. The dimensions between cell assemblies, as shown on the schematic, will also enable the observer to approximate the relative distances between each block of reflections. The following steps are given for an alignment check where the location of the misaligned component(s) is not known.

a. Place one of the opaque cards (Item 3, Table 6-1) behind the objective in each optical path; i.e., on the end of the cell nearest the MEP or the celestial sphere.

b. Place an opaque card on top of the beamsplitter and, using the reflection technique (refer to paragraphs 6-10 through 6-12) check the alignment of the starfield optical path. If correct alignment is apparent, proceed to step e.

c. If a misalignment appears in the starfield path, it can be safely assumed that the misalignment is the result of a displacement of either mirror assembly -166, mirror assembly -167, or of the objective -286. (See figure 6-1.) A deflection in the horizontal plane will require an azimuth adjustment of one or both mirrors (refer to paragraph 6-21); a deflection in the vertical plane will require an elevation adjustment of -166. (Refer to paragraph 6-22.) The construction of -167 does not incorporate an elevation adjustment.

d. If a mirror adjustment does not correct the misalignment, an adjustment of the objective lens mounting is indicated. (Refer to paragraph 6-23.)

e. Check the horizontal and objective leg of the MEP path plus the single cell -090 by placing the 90 degree prism (Item 2, Table 6-1) on top of the vertical coupled cell assemblies -090 and -145 (see figure 6-2) with the silvered hypotenuse surface facing outward. Use the reflection method to sight up through the single cell -090, through the coupled cell assemblies

-146 and -092 (as reflected by mirror assembly -222), and finally through the MEP objective -286 (as reflected by mirror assembly -166). If all the reflections are aligned proceed to step k.

f. If a deflection in the optical path appears as a misalignment of the last group of reflections (objective), while the rest of the reflections appear as a straight line, perform azimuth and elevation adjustments to mirror assembly -166 (refer to paragraphs 6-21 and 6-22).

g. If the mirror adjustments do not correct the error, adjust the MEP objective (refer to paragraph 6-23).

h. If the reflections from the coupled cell elements appear out of line with the first and last group of reflections, while the first and last group appear to be in line with each other, an adjustment of the coupled cell assemblies is indicated (refer to paragraph 6-24).

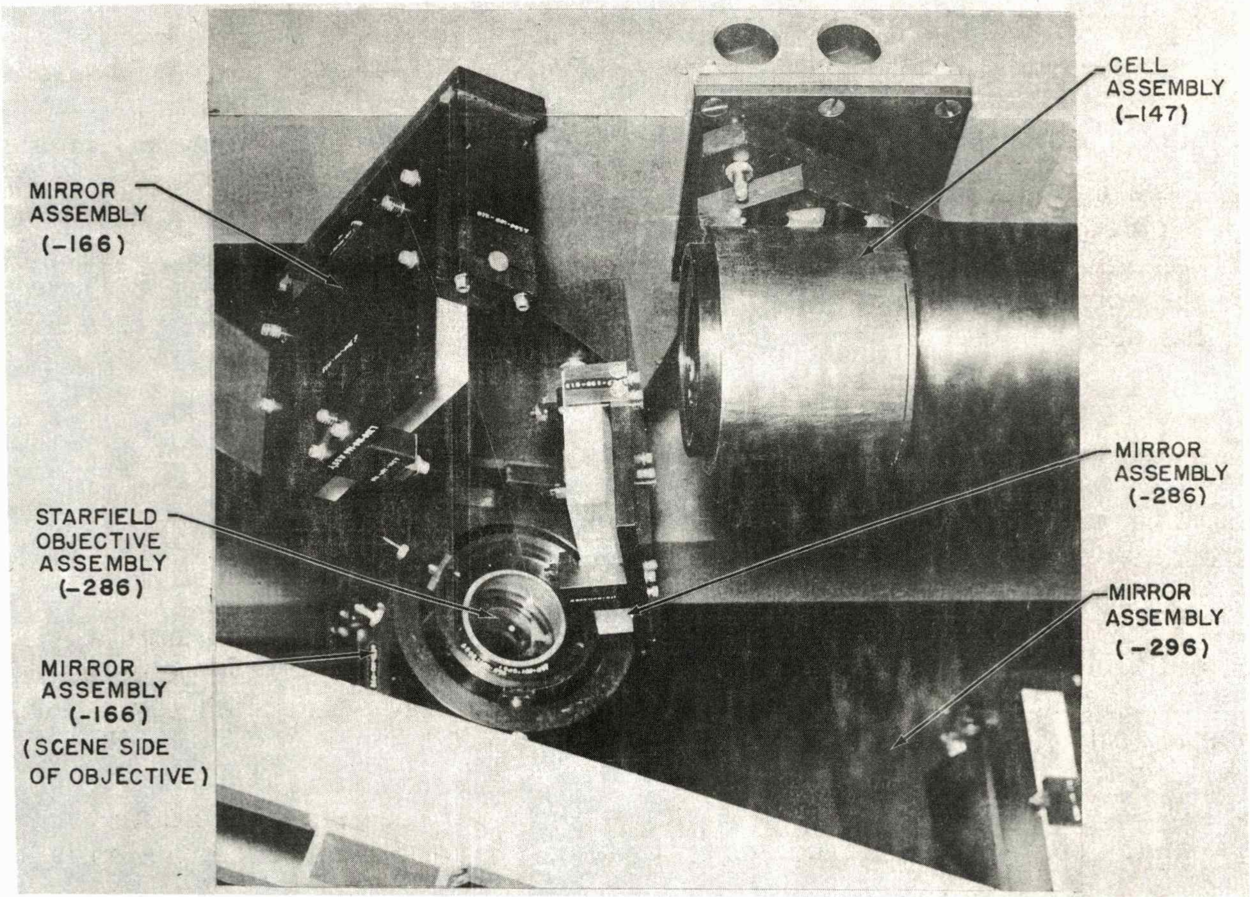
i. If the misalignment appears as a deflection of the first group of reflections out of alignment with all the rest of the reflections, first attempt to correct the misalignment by azimuth and elevation adjustments to mirror assembly -222 (refer to paragraphs 6-21 and 6-22).

j. If the mirror adjustments do not correct the error, adjust single cell assembly -090 (refer to paragraph 6-23).

k. Check the alignment of the entire MEP path, up to the objective, by removing the 90 degree prism from the path. Install the opaque card behind the cube beamsplitter and, using the reflection technique by sighting through the four inch diameter hole in the bridge face plate, check the cell elements reflections for alignment. If the alignment is correct both horizontally and vertically, proceed to step n.

m. If the first two groups of reflections appear to be out of line with the rest, adjust the position of the coupled cell assemblies -145 and -090. (Refer to paragraph 6-27.)

n. To check the coincidence of the two optical paths on the cube beamsplitter (-507), remove the opaque card from behind the cube and observe the reflections from both optical paths simultaneously. If each optical path appears to be properly aligned but not in coincidence on the beamsplitter, adjust the beamsplitter as required to achieve coincidence (refer to paragraph 6-27).



VSM6-1

Figure 6-1. Telescope Starfield Objective and Mirror Assemblies

6-18. Mirror Alignment Between Objectives and Scene Generation. (See figure 1-5.)

NOTE

Some of the procedures to follow are identical with some of the procedures in Section II, Functional Testing. Refer to Section II for manpower requirements and instructions for these procedures.

Locate and correct any misalignment in the individual optical paths between the beamsplitter and the two objectives. After bringing the paths into coincidence on the beamsplitter, check and correct (if necessary) a displacement of mirror assemblies -166 and -296 in the mission effects projector, LOS, or mirror assemblies -166, -296, and -301 in the starfield LOS. These procedures also include instructions for the correction of an out-of-focus condition caused by the axial movement of either of the objectives -286.

a. Install the reticle occulting and lens assembly -153 (refer to paragraph 4-11) but do not install the telescope cover panels.

NOTE

Observations by the senior technician during the balance of the alignment procedures must be made through the telescope eyepiece in the command module. Therefore, intercommunication equipment must be provided for the technician making the mirror adjustments, as well as for the electronic technician at the electronics cabinets, units 9 and 10.

b. Remove the opaque cards (item 3, table 6-1) from behind the objectives and beamsplitter.

c. Energize the electronics cabinets, units 9 and 10. Illuminate the telescope reticle and, if necessary, adjust the reticle for zero rotation.

d. Energize the C/S illuminator and occulting assembly to illuminate the celestial sphere. Perform the required procedures to rotate the celestial sphere until star Vega is centered in the illuminated field. Establish zero simulated roll, pitch, and yaw for the command module.

e. Observe the illuminated starfield through the eyepiece. If the star Vega appears correctly centered and focused on the reticle, proceed to step i.

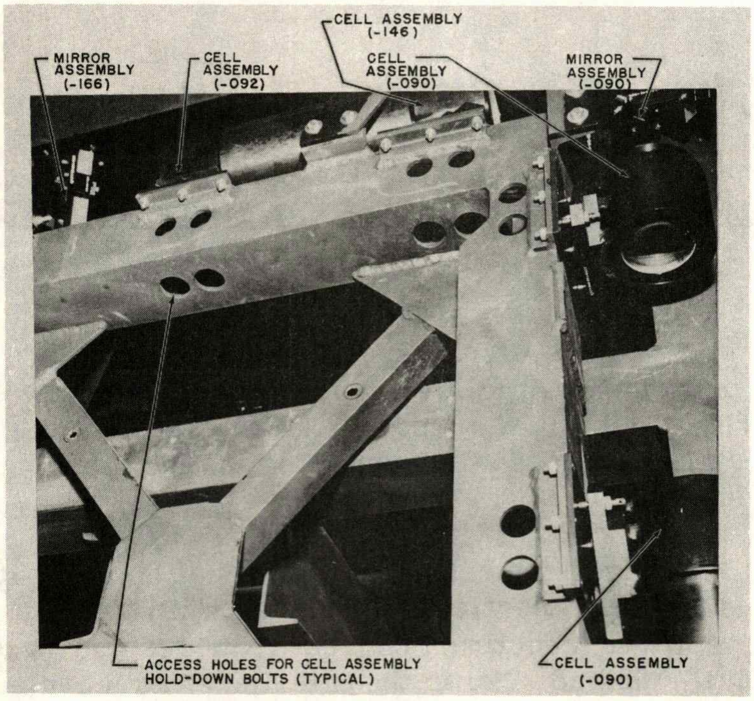


Figure 6-2. Horizontal and Vertical Legs of MEP Optical Path

f. If the star Vega is not centered on the reticle, perform azimuth and/or elevation adjustment of mirror assembly -166 and/or mirror assembly -296. (Refer to paragraph 6-26.)

g. If the star appears centered, but the entire 60 degree field of view is not evenly illuminated, adjust mirror assembly -301. (Refer to paragraph 6-27.)

NOTE

The initial adjustment of the celestial sphere illumination mirror is a function of the installation and adjustment of the C/S illuminator and occulting assembly.

h. Correct an out-of-focus condition for the starfield LOS as follows:

1. Tape a standard resolution pattern to a smooth surface on the celestial sphere. Manually rotate the sphere until the resolution pattern appears centered on the reticle.

2. Bring the resolution pattern to sharp focus, without the introduction of parallax, by axially adjusting the starfield objective. (Refer to paragraph 6-25.) Remove the resolution pattern from the sphere following the axial adjustment.

i. Deenergize the starfield scene generating equipment. Energize the MEP and perform the procedures required to present the test pattern for viewing. Introduce simulated command module zero roll, pitch, and yaw.

j. Observe the image of the test pattern on the reticle. If necessary, adjust mirror assemblies -166 and -296 in azimuth and elevation to center the test pattern on the reticle. (Refer to paragraphs 6-21 and 6-26.)

k. Adjust for good focus, without the introduction of parallax, by axial adjustment of the MEP objective -286. (Refer to paragraph 6-25.)

6-19. Upon completion of the alignment procedures, deenergize the electronic cabinets (units 9 and 10). Carefully inspect and clean the optical surfaces as required and install the cover panels. Perform the functional tests, as outlined in Section II, to verify the results and assure correct telescope operation.

6-20. MIRROR AND CELL ASSEMBLIES ADJUSTMENTS. The following adjustment procedures are presented in the order in which they are most likely to be required.

6-21. Azimuth Adjustment for Mirror Assemblies on Optical Bridge. (See figure 6-3.)

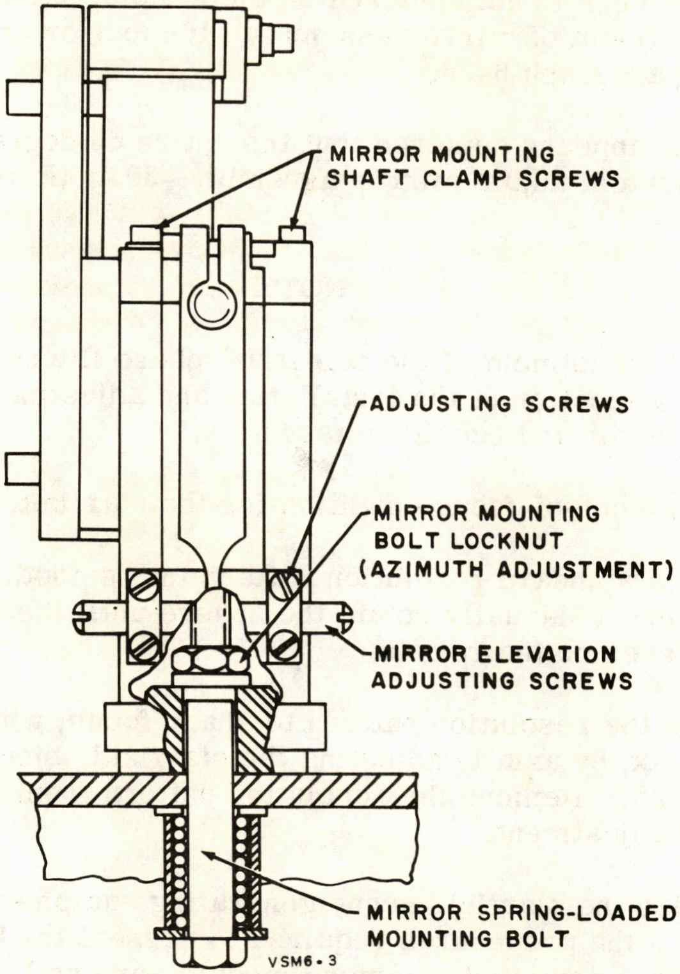


Figure 6-3. Typical Optical Bridge Mirror Assembly Adjustment

a. Loosen the mounting bolt locknut just sufficiently to release the pressure of the spring on the mounting bolt.

b. Following instructions from the observer, carefully tap the corners of the mirror mount until correct positioning has been achieved.

c. Tighten the mounting bolt locknut.

6-22. Mirror Elevation Adjustment. (See figure 6-3.)

a. Loosen the mirror mounting shaft clamp screws at both ends of the mirror just sufficiently to permit shaft rotation.

b. Loosen the four adjusting screw clamp screws.

c. As directed by the observer, back off one of the adjusting screws and tighten the opposite screws until correct elevation is achieved.

d. Secure the mirror in place by tightening all screws, that have been loosened.

6-23. Objective Cell and Single Cell Angular Adjustment. (See figure 6-4.) The objective cells and the single cell assembly -090 are secured to the optical bridge by two spring-loaded, socket-head cap screws threaded into the base plate of the cell. Access to the screw heads is provided through holes in the square-section bridge weldment members. Three leveling set-screws,

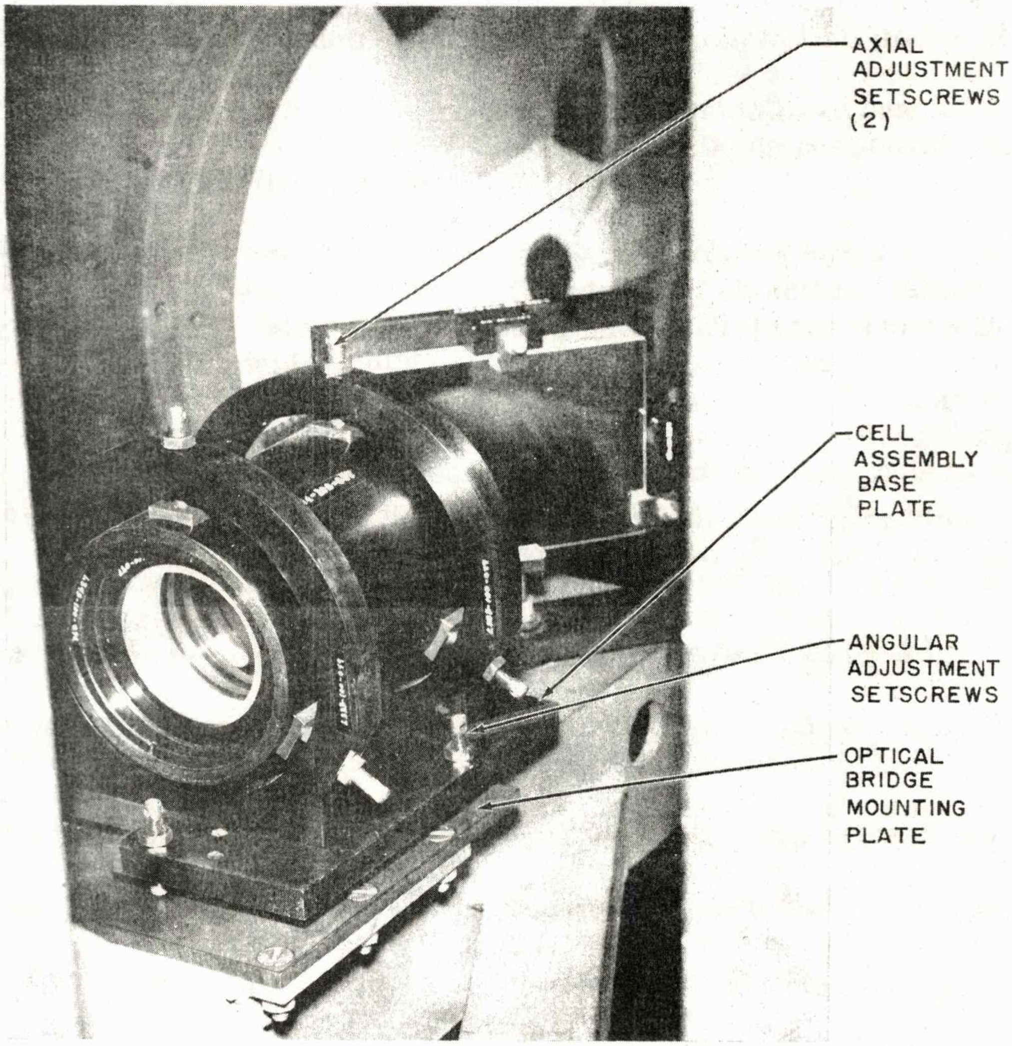


Figure 6-4. MEP Objective Cell Assembly

threaded through the cell base plate and bearing against the mounting plate, provide a means for adjusting the horizontal and vertical optical path angularity through the lens elements. The procedure is as follows:

a. Loosen the two mounting screws to relieve the spring tension.

b. As directed by the sighting observer, adjust the leveling screws, after loosening the locknuts, to correct the optical path alignment.

c. When alignment is achieved, tighten the mounting socket-head screws and the adjustment set screw locknuts.

6-24. Coupled Cells Angular Adjustment. (See figure 6-2.) The mounting and adjustment of the coupled cell assemblies is similar to the mounting and angular adjustment of the single cells. One mounting socket-head cap screw is used at each end of the assembly. Access holes through the optical bridge member are shown in figure 6-2. Two, instead of three, leveling set screws are threaded through each of the cell base plates. Angular adjustment procedures are essentially the same as those described in paragraph 6-23.

6-25. Objective Cells Axial Adjustment. (See figure 6-4.) A slight amount of axial movement of the objectives, in either direction, along the optical path will obtain optimum focus. This is accomplished by loosening one set screw in each of the mounting rings just sufficiently to permit movement of the cell assembly. When correct focusing is observed, retighten the set screw and locknut.

6-26. Azimuth Adjustment of Frame-Mounted Mirrors. (See figure 6-5.) To perform an azimuth adjustment of frame-mounted mirrors, proceed as follows:

a. Loosen the two locknuts to permit mirror mounting frame rotation.

b. Loosen the adjustment screw clamping screws.

c. As directed by the observer, turn the adjusting screws until the correct azimuth position is achieved.

d. Tighten all screws and locknuts to hold mirror in position.

The elevation adjustment of these mirrors is identical with that described in paragraph 6-21.

6-27. Cube Beamsplitter Adjustment. (See figure 6-6.) The cube beamsplitter mounting on the optical bridge is similar to the objective cell mounting in that the beamsplitter assembly base plate is held down by two spring-loaded mounting bolts threaded into the base plate. However, the leveling

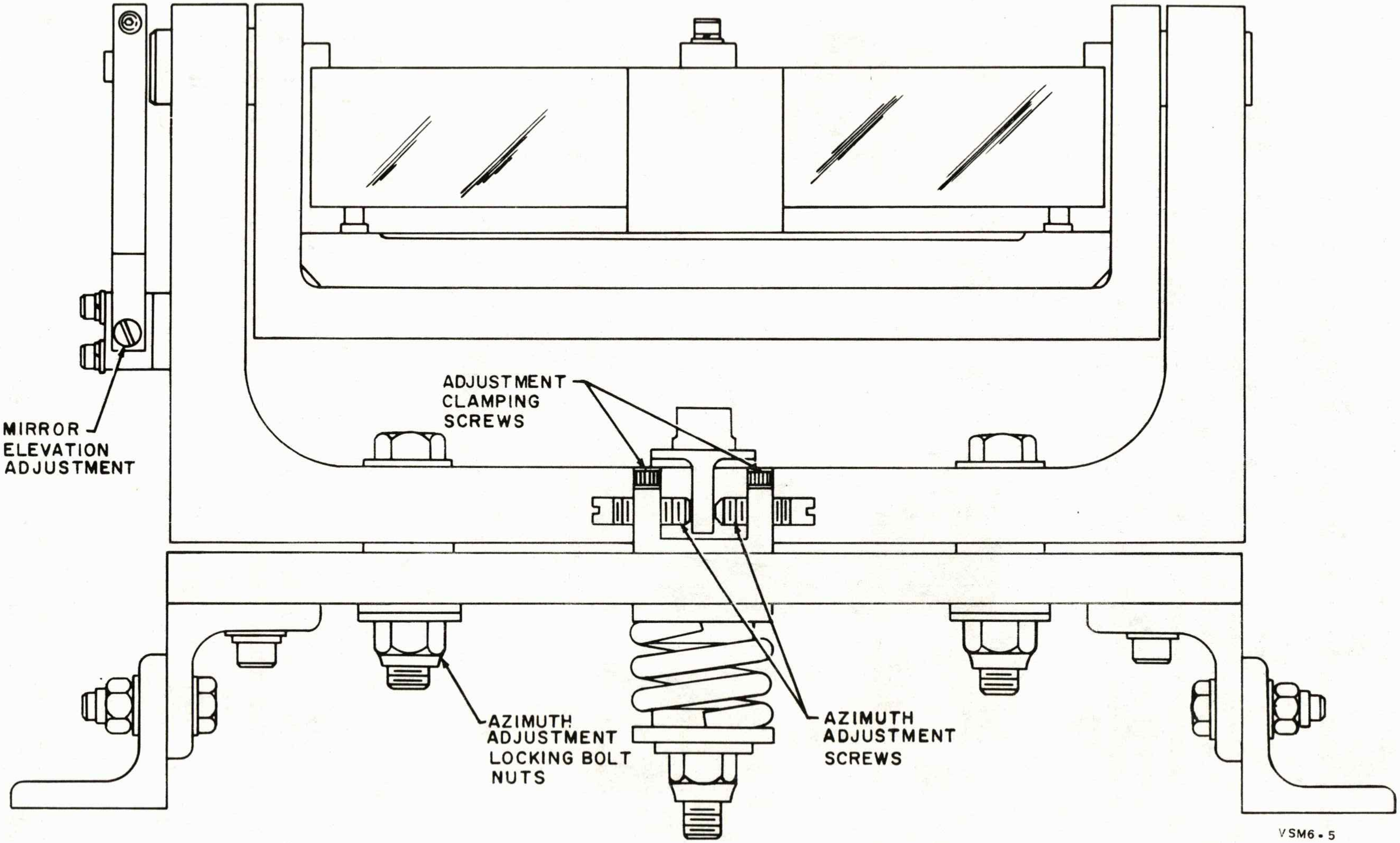


Figure 6-5. Mirror Assembly -296 and -301 Azimuth Adjustment

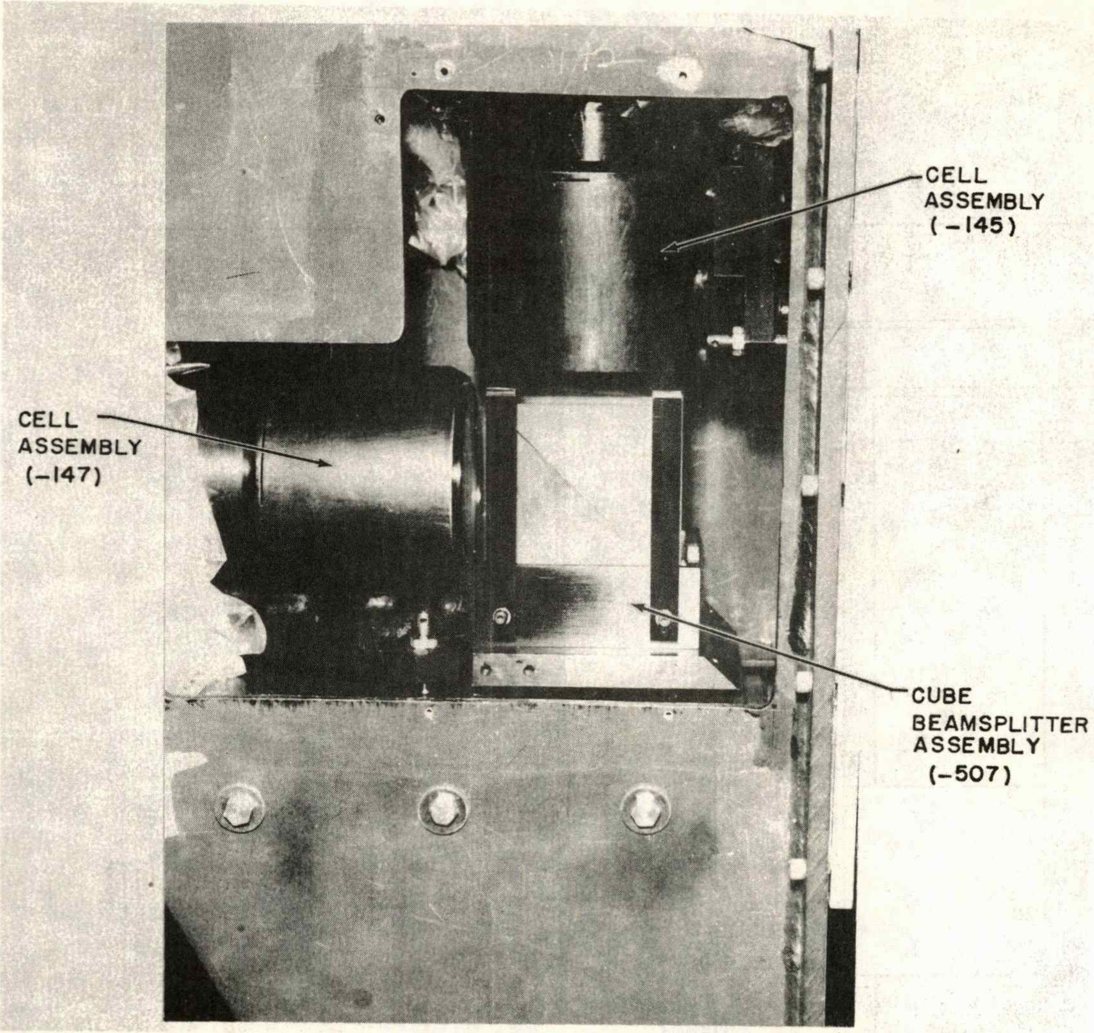


Figure 6-6. Telescope Cube Beamsplitter

(or adjustment) set screws are threaded through tapped holes in the mounting plate, fastened to the optical bridge weldment, and bear against the undersurface of the assembly base plate. There are four adjustment screws and, when required, the beamsplitter is adjusted to bring the MEP and starfield optical paths into coincidence. This adjustment is accomplished by loosening the mounting bolts to relieve the spring tension, and then alternately loosening and tightening the appropriate set screws. Following adjustment, the mounting bolts are tightened to hold the beamsplitter securely in position.

6-28. SEXTANT.

6-29. The succeeding paragraphs describe the procedures to be performed prior to and during the replacement of a defective assembly on the optical

bed plate. These procedures must be followed in order to maintain, within permissible limits of error, the optical alignment established at the time of sextant assembly and verified at the time of acceptance testing. The procedures are performed as follows:

a. Measure and record the position of the defective assembly on the optical bed plate, relative to the sides and/or ends of the plate, very previously prior to removal.

b. Duplicate the optical bed plate set-up on an accurate surface plate, using the defective assembly to establish reference dimensions for surface plate measurements of the replacement assembly.

c. Setup the replacement assembly on the surface plate, adjust the mounting pads, and position the assembly and associated test equipment, etc., to correspond with the values obtained in step b.

d. Install the replacement assembly on the optical bed plate, using the measurements taken in a. Adjust the replacement assembly before tightening the fasteners so that the dimensions are exactly the same as recorded in step a.

e. Zero the servos and perform the functional tests (refer to Section II) to assure correct sextant performance.

6-30. All assemblies mounted on the upper surface of the optical bed plate are supported on rectangular pads that are very accurately finished to provide the required height above the bed plate for the optical axes. The mounting pads under all of the assemblies, except the variable magnification assembly, are screw-fastened to the bed plate; the pads supporting the variable magnification unit are secured to the assembly itself.

CAUTION

Extreme care must be exercised, during the performance of the following procedures, to assure that the mounting pads under a particular assembly do not become inter-mixed with relation to the corresponding support points of the replacement assembly. In detail this means:

a. When a mounting pad is removed from the optical bed plate and placed on the surface plate, and vice-versa, the edges of the pad must be oriented exactly as when removed, and the pad must not be turned over.

b. When on the surface plate, and when returned to the optical bed plate, each pad must be under the same support point of the assembly as in the original installation.

The necessity for the strictest observance of this CAUTION cannot be overemphasized.

6-31. The text of this section is addressed to an optical instrumentation technician thoroughly versed in optics phraseology, experienced in the use of optical test equipment, and highly skilled in taking very precise measurements. The sequential order of the paragraphs is based on the replacement of major assemblies in the landmark LOS first, and then in the starfield LOS. In the landmark LOS, the variable magnification system is the most critical. The coincidence of landmark and starfield image on the focal plane of the reticle is dependent on the landmark LOS for proper sextant performance.

6-32. Test Equipment and Tools Required. Optical and mechanical instruments and measuring devices are required for the performance of the alignment procedures described in this section (refer to Table 6-1).

6-33. PRIOR TO REMOVAL MEASUREMENTS. Certain critical measurements, relative to the exact position of assemblies on the optical bed plate, must be taken and recorded prior to removal of a defective assembly. The dimensions are illustrated in figure 6-7 for the slide gate assembly, and in figure 6-10 for the starfield generator assembly.

6-34. PRIOR TO REMOVAL PREPARATORY PROCEDURES. Refer to Section IV, table 4-1, and succeeding paragraphs for instructions on necessary procedures prior to removal of optical bed plate assemblies.

6-35. LANDMARK SLIDE GATE REPLACEMENT. (See figure 6-7.) The following steps are used in replacement of the landmark slide gate:

a. Using a depth micrometer (item 8, Table 6-1) accurately measure and record dimension A (see figure 6-7) from the carousel side of the optical bed plate to the outboard end of the slide gate. Make the measurement approximately midway between the front and rear surfaces of the assembly.

b. Accurately measure and record dimension B, from the light source end of the optical bed plate to the rear surface of the slide gate. Take and record the measurement at both ends of the slide gate to establish the angularity with respect to end of the bed plate.

c. Remove the three hold-down capscrews (see figure 4-11) and remove the slide gate from the optical bed plate. Place the slide gate on the surface

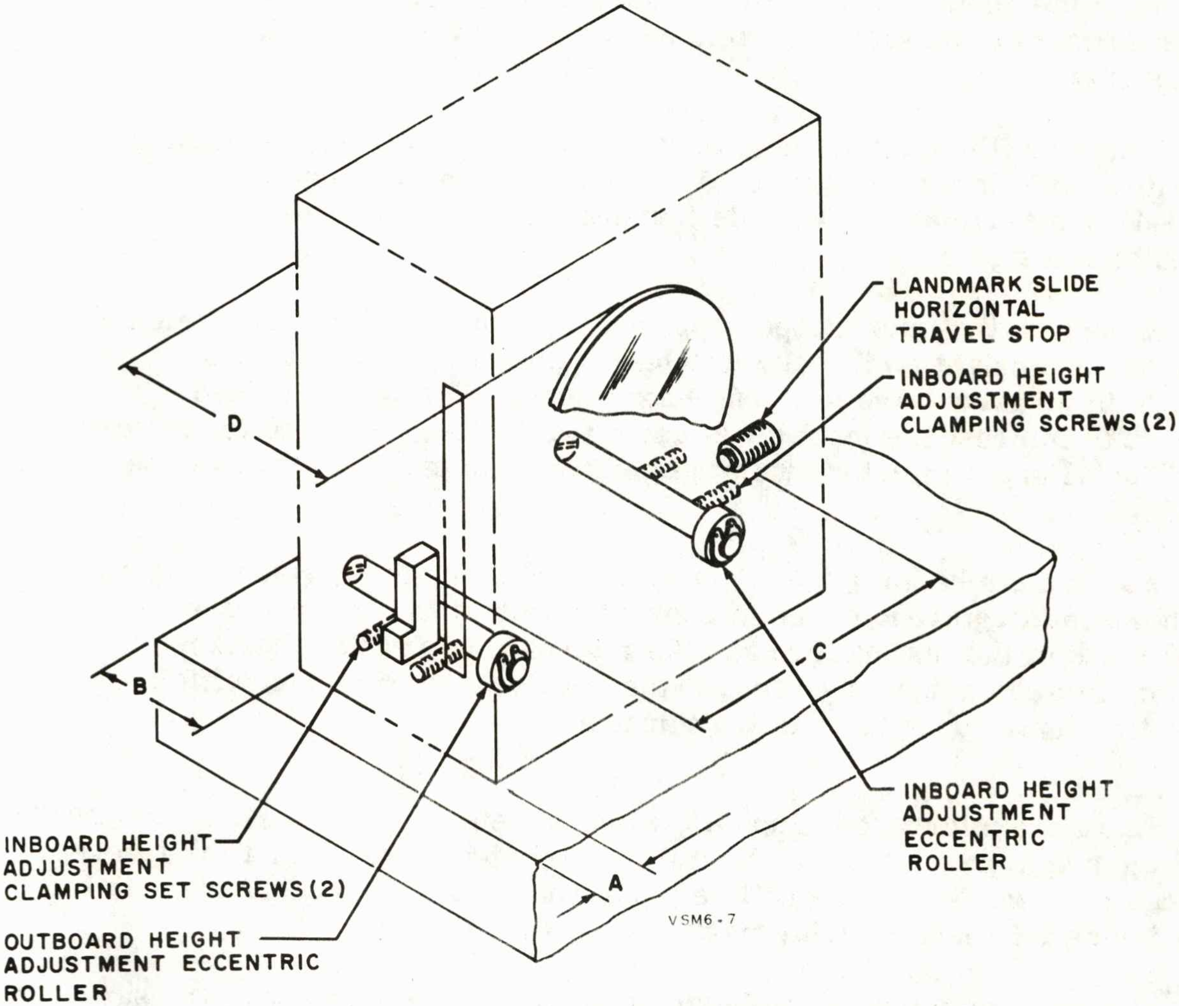


Figure 6-7. Landmark Slide Gate Critical Dimensions and Adjustments

plate (item 6, Table 6-1). Observe the CAUTION in paragraph 6-30. Remove the three rectangular mounting pads from the bed plate and position them in their corresponding positions under the slide gate on the surface plate.

d. Verify, with a machinist's square (item 9, Table 6-1) that the slide gate, supported on the mounting pads, is square with the surface plate.

e. Using the depth micrometer, measure and record dimension C from the outboard horizontal guide roller bracket surface to the stop which limits the horizontal motion of a landmark slide in the gate.

f. Carefully insert the opaque test pattern slide (item 13, Table 6-1) into the slide gate, and position it securely against the horizontal motion stop.

g. With the depth micrometer measure and record dimension D from the rear surface of the slide gate to the rear glass surface of the test pattern slide.

h. Place an illuminated light source (item 11, Table 6-1) behind the test pattern slide in the slide gate. Position a test microscope (item 4, Table 6-1) in a vertically adjustable test support (item 12, Table 6-1) in front of the slide gate.

i. Maneuver the microscope support on the surface plate and adjust the microscope height so that the left-hand fiducial mark on the test pattern is in focus with the horizontal axis of the microscope's fixed reticle. The microscope must be adjusted vertically so that the lower edge of the fiducial mark registers with the horizontal axis of the microscope reticle.

j. Assemble a height gage (item 7, Table 6-1) on the surface plate so that a horizontal reference edge is approximately at the height of the fiducial mark of the test pattern and the microscope's reticle horizontal axis. Position the height gage so that the light source provides sufficient illumination for viewing through the microscope.

k. Move the microscope support, without disturbing the vertical setting, so that the height gage is in focus. Adjust the height gage so that the reference edge is in index with the reticle's horizontal axis in accordance with the test pattern's left-hand fiducial mark in step i., above.

m. Record the height of the height gage reference edge above the surface plate, and label it "left-hand fiducial mark".

n. Repeat steps i. through m. for the right-hand fiducial mark, labeling the recorded measurement "right-hand fiducial mark".

o. Remove the test pattern slide from the slide gate.

p. Carefully lift the defective slide gate from the mounting pads, place the replacement slide gate on the pads, and verify that the new slide gate is square with the surface plate.

q. Using the depth micrometer, repeat the measurement described in step e., above, to obtain dimension C for the new slide gate's adjustment screw. If required, adjust the screw in or out until dimension C is the same for both slide gates.

r. Place the test pattern slide in the new slide gate and measure and record dimension D, the distance between the rear surface of the slide gate and the rear glass surface of the test pattern slide.

NOTE

This measurement is most important. It will be used in conjunction with dimension B, recorded in step b., to position the new slide gate axially in the landmark LOS on the optical bed plate.

s. With the light source behind the new slide gate, adjust the microscope (which is still vertically adjusted for "right-hand fiducial mark" observed in step n.) to focus on the right-hand fiducial mark of the test pattern as installed in the new slide gate. If necessary, loosen the two set screws and adjust the eccentrically mounted inboard roller to bring the lower edge of the fiducial mark into coincidence with the horizontal axis the microscope reticle.

t. Using the dimension recorded in step m., adjust the microscope for the height above the surface plate of the "left-hand fiducial mark".

u. Repeat step s. to obtain correct height positioning of the outboard roller after loosening the set screws. This should duplicate the height position of the test slide for the new slide gate with that measured and recorded for the old slide gate.

v. Remove the test slide from the slide gate, replace and fasten the mounting pads in their original position on the optical bed plate, and position the new slide gate on the pads.

w. Refer to dimension A, measured and recorded in step a. Use the depth micrometer to accurately position the slide gate with respect to the side of the optical bed plate.

x. Compare dimension D for the old and new slide gate and use the difference, if any, to compute dimension B for both ends of the new slide gate. Using these dimensions and the depth micrometer, position the slide gate with reference to the end of the bed plate.

y. When the slide gate is properly positioned, install and tighten the hold-down cap screws. When the sextant is re-assembled, perform the functional tests described in Section II to verify correct slide gate replacement.

6-36. LANDMARK RHOMB SCANNER REPLACEMENT. (See figure 6-8.) The rhomb scanners do not require extremely high accuracy in lateral positioning between the ends of the optical bed plate, but are affected by angular displacement relative to the sides of the bed plate. Therefore, it is important that a replacement scanner assembly be positioned so that the end plates are perpendicular to the sides of the optical bed plate.

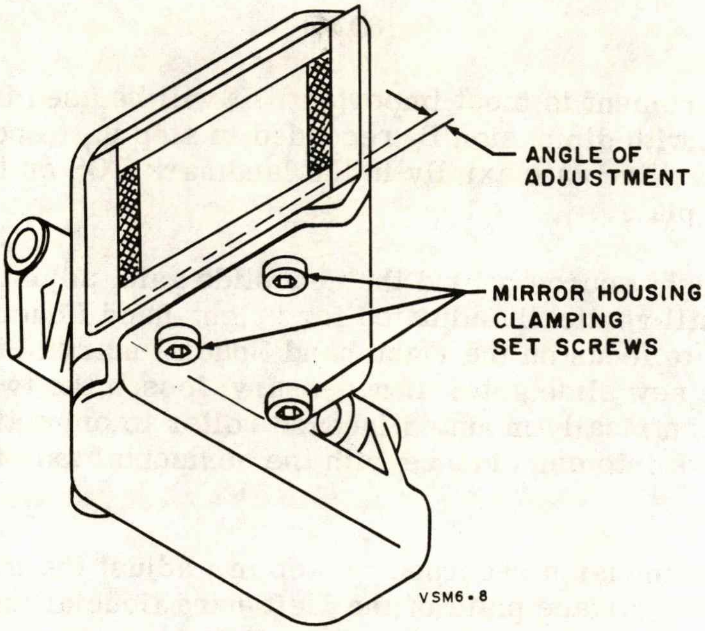


Figure 6-8. Mirror Rhomb Adjustments and Clamping Screws

6-37. The viewing procedures, called out in the instructions to follow, refer to substituting the eyepiece lenses assembly with a tubular microscope and adapter (item 5, table 6-1), to provide a sharper and more detailed image on the sextant's reticle. The unscrewing of two captive socket head cap screws will permit sliding the eyepiece lens assembly out of the eyepiece housing. The opening in the eyepiece housing provides a slip fit for the adapter in which the tubular telescope (without reticle) is hand adjusted for best focus. The above procedure applies when the sextant is not removed from the supporting structure. When the sextant has been removed, a more practical method of viewing is by threading the adapter directly into the rotating reticle assembly.

6-38. The procedures for replacement and alignment of the landmark rhomb scanner are as follows:

a. Verify, with a machinist's square, that the end plates of the scanner to be removed are perpendicular to the adjacent side of the optical bed plate.

b. Remove the scanner assembly from the bed plate and install the replacement scanner.

c. Using the machinist's square, adjust the scanner so that the end plates are perpendicular to the bed plate side. Tighten the hold-down cap screws and remake the electrical connections.

d. Refer to Section II. Energize the electronics cabinet (unit 9) and establish functional test conditions for the sextant.

e. Observe the images of the landmark test pattern and the navigational star on the sextant's reticle. Use a microscope attached to the eyepiece casting, or the rotating reticle assembly (refer to paragraph 6-37). If the required superimposition of the center of the test pattern and navigational star on the reticle center is not observed, adjust the landmark Alpha and Beta two-speed test directors to achieve the superimposition. Ignore the 1X and 32X resolver dial readings, since the servos have not as yet been zeroed.

f. Turn the Alpha rhomb 32X test resolver to cause the test pattern to apparently move across the navigational star image. Note whether the star remains within the line width of the landmark Alpha rhomb arc for at least plus or minus five degrees of test pattern movement. If the result is negative, observe whether the test pattern describes an arc too short or too long in radius.

g. On the basis of step f., if the results were negative, loosen the mirror rhomb clamping screws and adjust the mirror rhomb housing in the casting. tighten the clamping screws and repeat step f.

h. Repeat steps f. and g. until rotation of the Alpha rhomb 32X test resolver produces apparent test pattern movement with the navigational star remaining within the line width of the Alpha rhomb arc for the required plus or minus five degrees.

i. Repeat steps f., g., and h., using the Beta rhomb 32X resolver until the apparent movement of the test pattern across the navigational star results in the star remaining within the width of the Beta rhomb arc for plus or minus 10 degrees of apparent test pattern movement.

j. When correct landmark rhomb scanner performance has been achieved, zero the Alpha and Beta servo systems.

6-39. LANDMARK VARIABLE MAGNIFICATION SYSTEM. (See figure 6-9.) The variable magnification system is the most critical assembly in the sextant, insofar as precision alignment is concerned. When the sextant is initially aligned, the variable magnification system, the slide gate assembly, and the landmark rhomb scanner assembly are the first three units brought into alignment. All other assemblies are aligned to the optic axis established by the variable magnification system. Therefore, extreme care must be exercised in replacing a complete variable magnification system in as assembled sextant. The motor-generator and resolver servo system can be replaced without disturbing the assembly mounting on the optical bed plate. To replace the variable magnification assembly proceed as follows:

a. Remove the motor-generator and resolver servo components from the assembly.

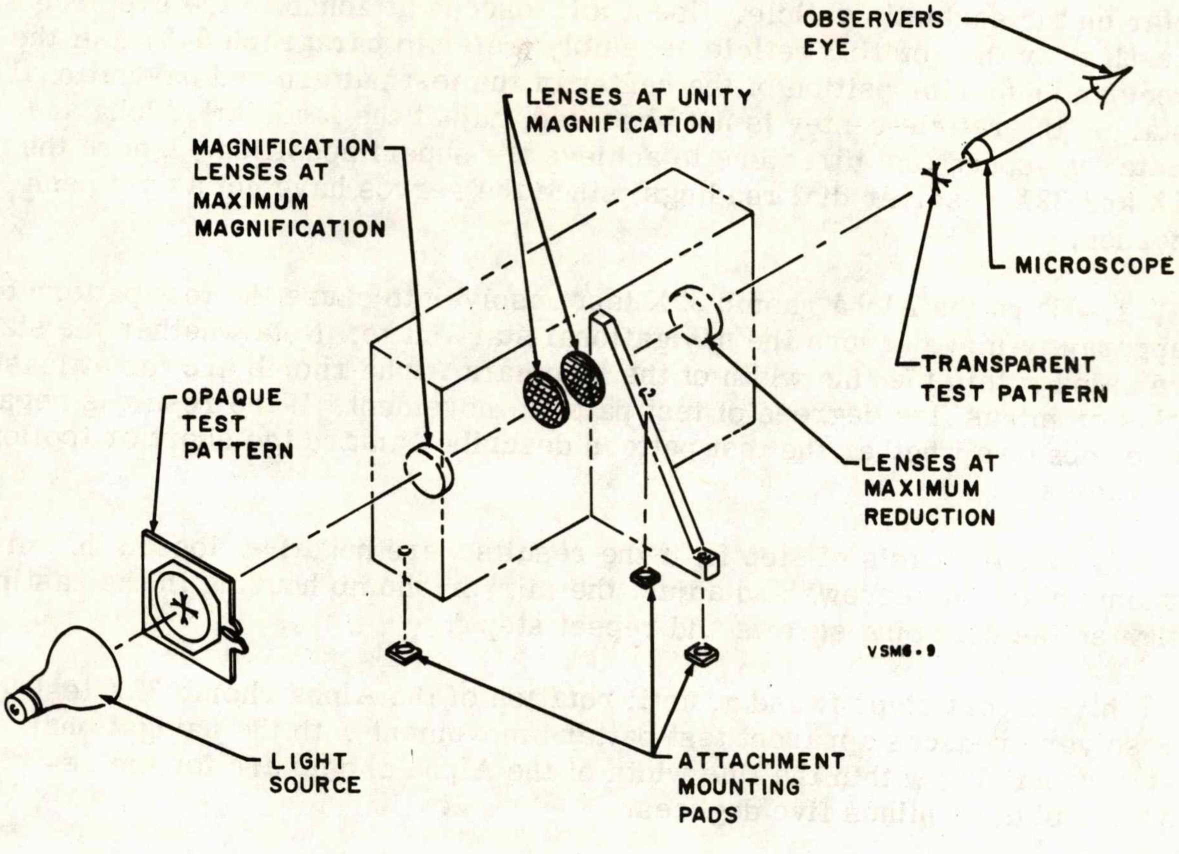


Figure 6-9. Variable Magnification System Alignment Setup

b. With a depth micrometer (item 8, table 6-1), accurately measure the distance from the adjacent edge of the optical bed plate to each of the assembly and record the dimensions.

c. Place a short steel parallel (item 10, table 6-1) on the bed plate between the end of the variable magnification assembly and the mounting leg of the landmark right angle mirror. Position the parallel in contact with the end of the assembly and clamp it to the bed plate.

d. Refer to table 4-1 and see figure 4-11. Remove the three cap screws and transfer the variable magnification assembly from the optical bed plate to the surface plate (item 6, table 6-1). As noted in paragraph 6-30, the mounted pads are fastened to the assembly, not to the bed plate; a replacement variable magnification assembly is supplied with mounting pads attached.

NOTE

The following procedures are required to establish coincidence of the optic axis of the replacement variable magnification assembly, following installation, with the optic axis of the assembly being removed.

e. Clamp an eight-inch long parallel to the edge of the surface plate. Position the removed magnification assembly on the surface plate and establish its lateral position by using the depth micrometer to duplicate the measurements taken and recorded in step b., above. Place a machinist's square (item 9, table 6-1) against the parallel and bring the blade end of the square into contact with the end of the variable magnification assembly.

f. A small scribe mark on the upper surface of the cam plate, at the approximate center of the curvature, marks the position of the cam roller when the system is set for unit (1:1) magnification; i.e., with the lenses most widely separated. Measure the distance from the unity magnification scribe mark to the end of the assembly.

g. Place the blade of a small machinist's square on the surface of the cam, with the edge of the blade coincident with the scribe mark. Carefully move the carriage of the lens holders until the cam roller is just in contact with blade. The lenses are now positioned for unity magnification.

h. See figure 6-9. Establish, on the surface plate, the alignment set-up as illustrated. The light source (item 11, table 6-1), test patterns (item 13, table 6-1), and microscope (item 5, table 6-1) are supported to portable, height-adjustable test fixtures (item 12, table 6-1). The opaque test pattern is oriented as it would be in the slide gate, and the supporting test fixture is positioned to place the pattern approximately 25 inches from the first lens unit of the variable magnification system. The transparent test pattern, similarly supported, is rotated 180 degrees about the optic axis and is positioned approximately 25 inches from the second lens unit.

i. Illuminated the light source and position it laterally and vertically behind the opaque test pattern. If necessary, provide shielding to eliminate distracting surrounding light.

j. Adjust both of the test pattern mounts laterally and vertically along the optic axis so that the opaque test pattern is superimposed and imaged exactly on the transparent test pattern, as viewed through the microscope. Clamp parallel bars to the surface plate, and against the foot of the opaque test pattern fixture, so that the test pattern (object plane) will remain correctly oriented with the optic axis. The object and image planes for the variable magnification system are now established.

k. Gently move the lens carriage of the assembly to either a position of maximum magnification or maximum reduction, while observing the center of the illuminated test pattern as imaged on the pattern in the image plane. Adjust the illuminated pattern laterally and/or vertically until the centers of the test patterns remain stationary when the variable magnification lenses are either at maximum magnification or maximum reduction.

l. Remove the old variable magnification assembly from the surface plate and install the replacement unit in approximately the same position. Using the dimension obtained in steps e. and f. above, position the new unit longitudinally by duplicating the dimension between the unity magnification scribe mark and the blade of the machanist's square.

m. Repeat procedure g. to establish unity magnification for the replacement assembly. Observe the image of the illuminated test pattern on the transparent pattern. Without disturbing the longitudinal position, adjust the assembly laterally to bring the test pattern centers into coincidence at the center of the image plane.

n. Repeat procedure k. with the replacement assembly. If the center of the test patterns do not remain stationary through the range of magnification, adjust the mountng pads by scraping or shimming until the optic axis is in the required location in elevation.

o. Use a depth micrometer to measure the distance between each end of the assembly and the parallel clamped to the edge of the surface plate; record the dimensions.

p. Place the replacement variable magnification unit on the optical bed plate. Position the unit laterally, using the dimensions obtained in step p. above. Verify that the unity magnification scribe mark is the same distance, longitudinally, from the clamped parallel bar as the dimension obtained in step m. Install the mounting cap screws and remove the clamped parallel bar.

q. Install the servo system removed from the replaced assembly in step a., establish electrical zero at unit magnification, and perform the functional tests described in Section II to verify correct performance.

6-40. ROTATING POLAROID ASSEMBLY. The rotating polariod assembly is the least critical assembly in the optical system with regards to alignment. The principal precaution to be observed is that no vignetting occurs when a replacement unit is rotated through 360 degrees, as observed through the sextant eyepiece.

6-41. STARFIELD GENERATOR ASSEMBLY. (See figure 6-10.) The starfield generator presents images of stars surrounding a navigational

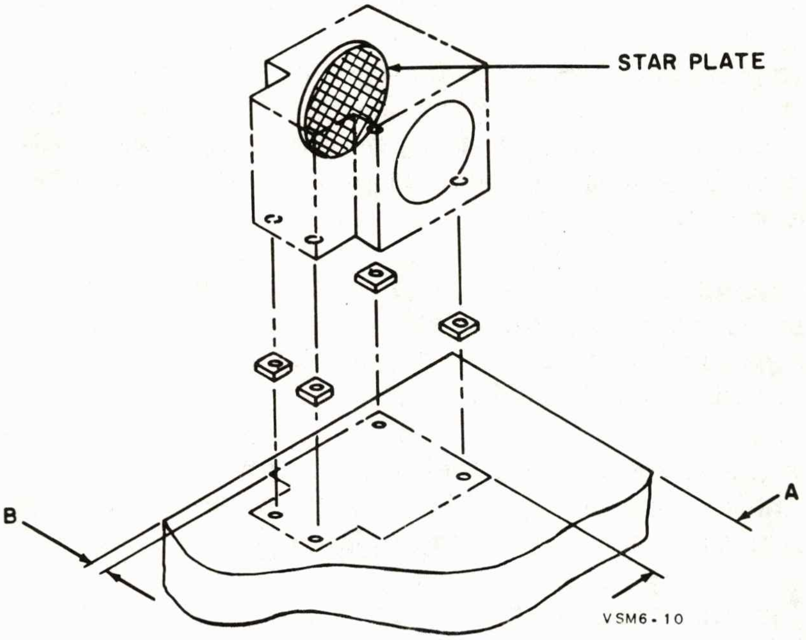


Figure 6-10. Starfield Generator Critical Mounting Dimensions

star. Since simulated navigational fixes are made only with the simulated navigational star, no measurements are made to any background star. Therefore, the important consideration in the replacement of a starfield generator is that the center of the star plate is in the starfield optic axis. Also, the assembly must be accurately positioned on the optical bed plate to put the star plate in object plane superimposed on the object plane of the navigational star. The procedures and measurements for the replacement of a starfield generator are as follows:

a. With a depth micrometer, (item 8, table 6-1) measure and record dimension B from the rear surface of the assembly to the end of the optical bed plate. Take the measurement at both sides of the assembly.

b. Measure and record dimension A, from the side of the assembly to the adjacent side of the optical bed plate; again, at both ends of the assembly.

c. Remove the starfield generator from the optical bed plate and place on the surface plate (item 6, table 6-1). Remove the spacers from the bed plate and place them under the assembly.

CAUTION

Extreme care must be exercised during the performance of the following procedures, to assure that the mounting pads under a particular assembly do not become inter-mixed with relation to the corresponding support points of the replacement assembly. In detail this means:

a. When a mounting pad is removed from the optical bed plate and placed on the surface plate, and vice-versa, the edges of the pad must be oriented exactly as when removed, and the pad must not be turned over.

b. When on the surface plate, and when returned to the optical bed plate, each pad must be under the same support point of the assembly as in the original installation.

The necessity for the strictest observance of this CAUTION cannot be over emphasized.

d. Measure the diameter of the inner surface of the star plate mounting.

e. Measure the distance from the inner lower surface of star plate mounting to the surface plate.

f. Measure the distance from the inner side surface of the star plate mounting to the inboard side of the starfield generator.

g. Measure the distance from the front surface of the star plate to the front surface of the assembly.

h. Measure the fore and aft thickness of the main block of the starfield generator.

i. Compute the position of the axis of rotation of the star plate with respect to the surface plate and the side of the starfield generator from the measurements taken.

j. Remove the old starfield generator from the surface plate. Leave the spacers in place and replace with the new starfield generator.

k. Take the measurements described in steps d. through h. above, and compute the position of the axis of rotation of the star plate with respect to the surface plate and the inner surface of the starfield generator.

l. Measure the distance between the rear surface of the assembly (nearest the light source) and the front surface of the star plate.

m. As required, scrape or shim (item 17, table 6-1) the mounting spacers in order to bring the axis of rotation into coincidence with the axis as computed in step i. above, with respect to height above the surface plate.

n. Using the measurements taken, calculate the depth micrometer readings which will place the axis of rotation of the replacement starfield generator in coincidence with the axis of rotation of the replaced starfield generator previously located on the optical bed plate.

o. Determine the correct location of the starfield generator to place the star plate front surface in the plane of the star plate front surface of the replaced starfield generator, as previously located on the optical bed plate.

p. Install the spacers and the replacement starfield generator on the optical bed plate. Make the electrical connections and perform the functional tests as described in Section II.

6-42. STARFIELD RHOMB SCANNER ASSEMBLY. The starfield rhomb scanner does not require extremely high accuracy in lateral positioning, but is sensitive to angular rotation. Therefore, it is important that the assembly is accurately perpendicular to the edge of the optical bed plate. The procedures for replacement and alignment of the starfield rhomb scanner are as follows:

a. Verify that the installed rhomb scanner end plates are perpendicular to the adjacent edge of the optical bed plate.

b. Remove the defective assembly and install the replacement starfield rhomb scanner. Make sure that the end plates are perpendicular to the edge of the optical bed plate.

c. Energize the electronics cabinet (unit 9), place the sextant components in the "test" condition as described in Section II, and install a microscope (item 5, table 6-1) either in the eyepiece assembly or in the rotating reticle (refer to paragraph 6-37).

d. Adjust the rhomb scanner laterally so that no vignetting is apparent.

e. Observe the navigational star as imaged on the reticle and superimposed on the landmark test pattern. As necessary, adjust the starfield Alpha and Beta test resolvers to bring the navigational star to the center of the test pattern.

f. Rotate the starfield Alpha rhomb 32X resolver to cause the apparent movement of the navigational star along the starfield Alpha rhomb arc of the test pattern. Observe whether the star remains within the line width of arc

within plus or minus 3.5 degrees of travel. If not, note whether the radius of the arc described by the star is too short or too long.

g. If the curvature of the arc is not of the desired radius, loosen the cap screws of the mirror mount housing and adjust the position of the housing, as described in paragraph 6-38 f and 6-38 g and illustrated in figure 6-8. Repeat the adjustment until the rotation of the Alpha rhomb maintains the star within the line width of the Alpha rhomb arc for plus or minus 3.5 degrees.

h. Repeat steps f. and g. using the starfield Beta rhomb 32X resolver. The navigational star must remain within the line width of the Beta rhomb arc for a minimum of plus or minus seven degrees of travel.

i. When the motion of the navigational star with respect to the test pattern image is correct, zero the Alpha and Beta servo systems.

6-43. ROTATING RETICLE ASSEMBLY. (See figure 6-11.) The rotating reticle assembly has three critical adjustments: focus, translation, and, after the above two have achieved, rotational zeroing. Figure 6-11 illustrates the reticle assembly with the two instruments mentioned in the following procedures. The replacement of a defective rotating reticle assembly is as follows:

a. Refer to paragraph 5-17 for instructions on edge-lighting lamp replacement. Remove the four edge lights. Scribing the reticle and clamp, as in 5-17c, may be deleted since the entire assembly is to be replaced.

b. Disconnect the remaining electrical leads at terminal board 12TB3. Loosen the inboard clamping screw, and, while holding the reticle assembly in place, remove the outboard clamping screw entirely.

c. Rotate the reticle until the leads are in line with the clamp opening thus provided. Remove the reticle assembly.

d. Install the replacement assembly, and pass the servo leads through the clamp opening. Rotate the reticle until the leads are in approximately the same radial position of those just removed. Install the outboard clamping screw and tighten both screws just sufficiently to hold the reticle in place.

e. Reconnect the motor and resolver servo leads to terminal board 12TB3, install the edge-lighting lamp inserts, and connect them to the terminal board.

f. Energize the electronics cabinet (unit 9) and place the sextant portion of the test panel in "test" condition. (Refer to Section II).

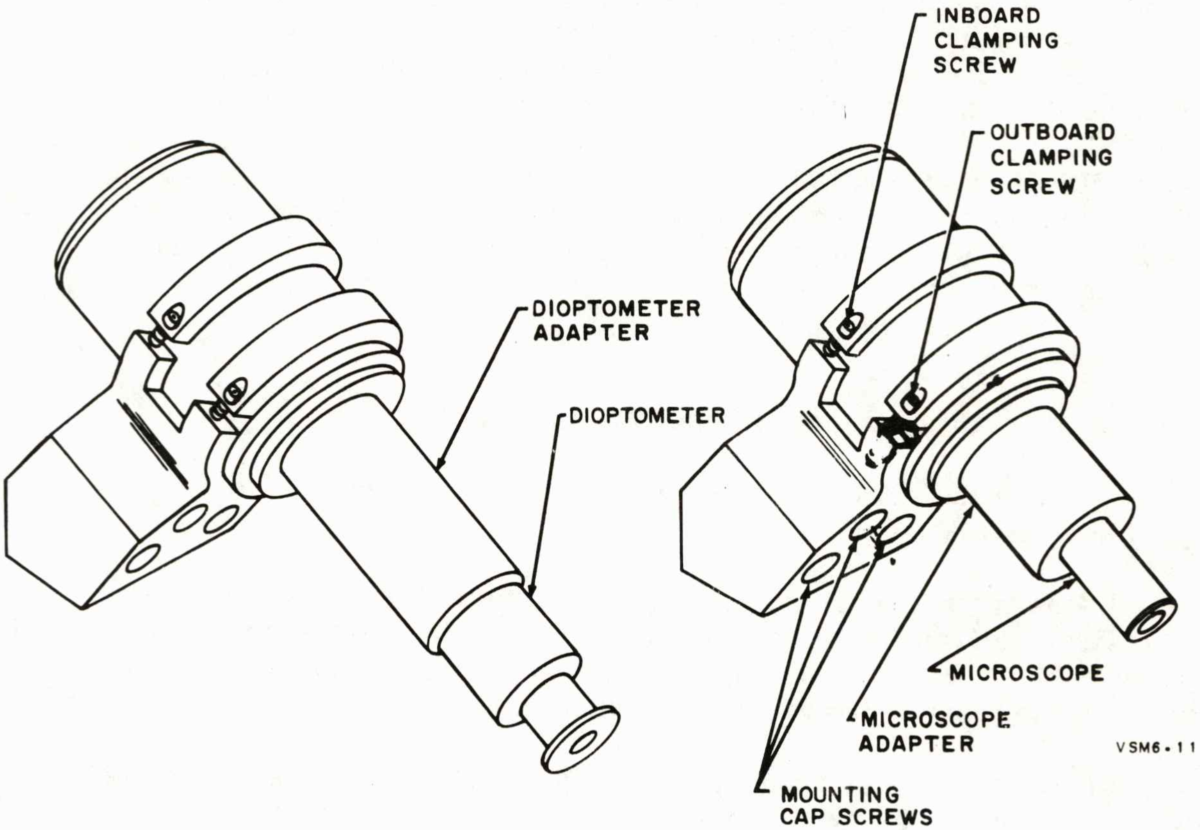


Figure 6-11. Rotating Reticle Assembly, Instruments and Adapters

g. Place the microscope and adapter (item 5, table 6-1) in the end of the center tube of the reticle assembly and adjust the microscope for focus on the reticle engraving.

h. Move the reticle assembly in the clamping rings along the line of sight to find the best focus for the test pattern in the plane of the reticle. Tighten the clamping rings snugly.

i. Replace the microscope and adapter with a dioptometer and its adapter (item 13, table 6-1).

j. Set the rotating reticle servo control on the test panel to "0". Observe the orientation of the test pattern with respect to the reticle. If necessary, loosen the clamping screws sufficiently to rotate the reticle - without axial movement - until the axes of the reticle and the test pattern coincide. Retighten the clamping screws.

k. Observe whether the central ring and opaque dot of the test pattern are centered on the reticle. If not, loosen the three reticle holder mounting screws slightly and, with a small wooden mallet or suitable implement, tap the holder horizontally and/or vertically to center the test pattern on the reticle. Retighten the mounting screws.

1. Replace the dioptometer with the microscope and verify that the test pattern image is in focus in the plane of the reticle. If not, loosen the clamping screws sufficiently to slide the reticle assembly along the optic axis, taking care not to rotate it. When focused, retighten the clamping screws.

6-44. CAROUSEL ALIGNMENT. No precise measurements can be given for the alignment of a replacement carousel assembly, since correct positioning will be determined only after manual operation of the slide actuator mechanism at several radial positions of the slide magazine. The recommended procedure is as follows:

a. Prior to removal of the carousel to be replaced:

1. Remove the slide magazine and slide actuator mechanism (refer to paragraphs 4-26 and 4-31).

2. Using the depth micrometer (item 8, table 6-1), measure and record the distance from the side of the optical bed plate to the center supporting post of the carousel. Measure and record the distance between the same post and the front and rear frame channels.

b. Install the replacement carousel, using the above dimensions to locate the center post; tighten the mounting cap screws securely.

c. Install the slide actuator mechanism and the slide magazine.

d. Slowly and carefully operate the slide injection rod by hand; observe the relative positions of the slide and the opening in the slide gate as the slide approaches the entrance guide rollers. If the alignment appears satisfactory, continue the manual injection until the slide is completely in the slide gate.

e. Illuminate the landmark optical path and observe, at the eyepiece, if the slide is correctly positioned with respect to the reticle engraving.

f. If, during step d., the slide appears to bind at any point of travel, retract the slide into the magazine. Loosen the carousel mounting cap screws and move the assembly in the direction indicated by the binding action. Retighten the cap screws and repeat steps d. and e. until the requirements of landmark slide positioning are satisfied.

g. Rotate the slide magazine manually to 6 different radial positions, approximately 60 degrees apart, and repeat steps d. and e. at each position.

h. When alignment requirements are satisfied, re-make the electrical connections, energize the electronics cabinet (unit 9), and establish electrical zero for the carousel rotation servo system.

i. Perform the functional tests for carousel rotation and landmark slide positioning as described in Section II.

6-45. TELESCOPE/SEXTANT ELECTRONICS CABINET.

6-46. Three categories of adjustment are necessary for circuits contained in the electronics cabinet. The first category is the power supply adjustments, some of which have already been covered in Section II. The second category is comprised of the electronic unit adjustments, which are normally required only when an electronics package is changed or when trouble is suspected. The final category consists of test panel adjustments, which are required when test panel units are replaced or when the test panel is disassembled.

6-47. POWER SUPPLY ADJUSTMENTS. To adjust the voltage of the plus 28-volt power supply and the plus 12-volt low-level power supply, refer to Section II. To properly adjust power supply voltages, the constant current control must be advanced far enough to enable the power supplies to supply the required load current. In the case of these two power supplies, the constant current control should be set near maximum. After the voltage is adjusted, the current control should be backed off until current limiting begins to become evident. When current limiting is evident, the control should be advanced again to approximately half way between that point and the maximum setting.

6-48. Adjustment controls of the plus or minus 12-volt high-current power supplies are covered in Section II. The power supplies should both be adjusted to 12.6 volts. The negative 12-volt power supply should be connected as the master.

6-49. ELECTRONIC UNIT ADJUSTMENTS. The electronic unit adjustments cover the d-c torque motor electronics and the a-c servo amplifiers. After adjusting the unit, the applicable test panel adjustments should be performed.

6-50. D-C Torque Motor Electronics. Three adjustments are required: the d-c balance adjustment, the loop gain adjustment, and the balance control adjustment. To adjust balance control:

a. Turn the GAIN control to its extreme clockwise position for zero gain. This assures that a-c signals are not being applied to the preamplifier.

b. Connect a low-range voltmeter (item 19, table 6-1) between the power ground terminal and the d-c torque motor output terminal on the terminal strip directly in front of the unit being adjusted. The voltmeter should have a full scale range of no more than about 2.5 volts.

c. Adjust the DC BALANCE control to bring the voltage to a value as near zero as possible. By adjusting the DC BALANCE control, it is possible

to cause the output voltage to be either positive or negative. However, the control should be adjusted to obtain as much of a null as possible with the d-c torque motor connected.

d. To adjust the gain, repeatedly apply a step input to the servo in the same manner as outlined in Section II, and observe the transient response of the servo. Advance the control as far as possible in an extreme counterclockwise direction consistent with good performance. The servo should settle quickly with no more than two or three overshoots.

6-51. A-C Servo Amplifier. Two adjustments, one for loop gain and one for damping control are required. The adjustments are started with both controls set at zero (fully counterclockwise). Continue the adjustment as follows:

a. Advance the LOOP GAIN,control and observe the servo step response (refer to Section II) until a highly oscillatory response is obtained. (The output member of the servo oscillates a relatively large number of times before finally coming to rest.)

b. Advance the DAMPING control until the desired degree of stability is obtained. (Step response of the servo has not more than two or three operations before coming to rest.)

6-52. TEST PANEL ADJUSTMENTS. The unit must be removed for adjustment and 400-cycle power must be supplied to the test panel to make the adjustments. Power should be supplied to pins J and D of test panel connector J5.

6-53. <u>Single-Speed Directors.</u> To properly zero single-speed directions on the test panel, correspondence between the electrical zero of the resolver transmitter used in the director and the zero marking on the dial must be established. Zeroing of the directors is accomplished as follows:

a. To determine the location of electrical zero, connect a voltmeter (item 19, table 6-1) across resolver terminals S2 and S4 and rotate the resolver by turning the director knob until the voltage reading is at a minimum. The point at which the voltage reading is a a minimum is either 0 degrees or 180 degrees.

b. To determine which of the two angular positions the resolver is in, refer to the phase of the voltage across winding S1-S3. If this voltage is in phase with the voltage applied to rotor terminals R1-R3, the resolver is at a true electrical zero. If the voltages are out of phase, the resolver is at 180 degrees.

c. To determine which of the above conditions exists, connect a clip lead between the S1-S2 terminal of the resolver and the R1 terminal of the

resolver. Connect a voltmeter between terminals R3 and S3. If the two voltages are in phase, the voltage measured between S3 and R3 will be their difference, or approximately 14 volts. If these two voltages are not in phase, the voltage appearing between R3 and S3 will be their sum, or 38 volts. Consequently, if the voltage measured between R3 and S3 is in the vicinity of 14 volts, the resolver is adjusted to its true electrical zero. If the voltage is in vicinity of 38 volts, the resolver is at 180 degrees and should be rotated 180 degrees to obtain a true electrical zero.

d. Once the electrical zero is obtained, remove the clip lead and connect a low-range voltmeter across S2-S4. Carefully adjust the director knob until as fine a null as possible is obtained. This is the true electrical zero.

e. Once the electrical zero is obtained, loosen the set screw on the resolver dial and rotate the dial until the zero degree mark is aligned with the dial index while resolver remains at its electrical zero.

f. Tighten the set screw and check that the electrical zero still corresponds with the zero indication on dial.

6-54. Two-Speed Directors. To align two-speed directors, a similar procedure to that given in paragraph 6-53 is followed; however, transmitters must be aligned with respect to each other as well as with respect to their respective dials. This is accomplished in the following manner:

a. Align the one-speed resolver with respect to its dial in the same manner as was used for the alignment of single-speed directors in step a. of paragraph 6-53.

b. Loosen the mounting clamp screws for the 32-speed resolver and, holding its shaft stationary, rotate the resolver body while observing the voltage between terminals S2 and S4. Continue rotating the resolver until a null is obtained.

CAUTION

> When conducting this procedure, make sure that the one-speed resolver remains aligned with zero degree mark.

c. If difficulty is experienced during this procedure (dial moves as adjustment to 32-speed resolver is being made), apply a piece of masking tape across the 32-speed dial to temporarily hold the one-speed resolver aligned to its electrical zero.

d. Once a null position of the 32-speed resolver is found, tighten the resolver mounting screws and check the alignment of zeros of both of the

resolvers. Connect another voltmeter (item 19, table 6-1) across the S2-S4 winding of each resolver and rock the knob controlling the 32-speed shaft several degrees each side of zero. Both voltmeters should null at the same point. If they do not, readjust the 32-speed resolver until they do.

e. At this point, the 32-speed resolver is either aligned with the one-speed resolver or is 180 degrees out of phase with it.

f. To determine which of above conditions exists, make the following measurements. It should be noted at this point that up to 5.6 one-speed degrees, the sine windings of the one-speed resolver and the 32-speed resolver should be in phase.

(1.) Connect S1-S2 terminals of both resolvers together with a clip head.

(2.) Set the one-speed resolver to 2.81 degrees. (This can be easily accomplished by observing the two-speed dial. The reading at which the zero of the 32-speed resolver corresponds to the zero of the one speed resolver is the desired setting.)

(3.) Advance the 32-speed dial by 90 degrees in an increasing direction. At this point, the voltage across the 32-speed S2-S4 winding will be at a maximum, or approximately 12 volts. The voltage across the one-speed S2-S4 winding will be maximum, or approximately 0.6 volts. If the two voltages are in phase, the voltage measured between S4 of the one-speed resolver and S4 of the 32-speed resolver should be the difference, or 0.6 volts less than the voltage at the S2-S4 terminals of the 32-speed resolver. If the two voltages are not in phase, the voltage between the two S4 terminals will read 0.6 volts more than the voltage across the S2-S4 winding of the 32-speed resolver.

(4.) Measure the voltage between the S4 terminals of two resolvers. If this voltage is less than the S2-S4 voltage of the 32-speed resolver, the two resolvers are correctly aligned. If the voltage is slightly more than the S2-S4 voltage of the 32-speed resolver, this resolver is incorrectly aligned with the one-speed resolver. The above alignment procedure should then be repeated after first loosening the mounting screws on the 32-speed resolver and rotating its body approximately 180 degrees while holding the one-speed shaft aligned to its electrical zero. Once electrical zeros of the two resolvers are aligned and the one-speed dial is aligned with the electrical zero of the one-speed resolver, loosen the set screw on the 32-speed dial and, keeping the 32-speed resolver aligned with its electrical zero, rotate the dial of the 32-speed resolver until zero degrees corresponds to the index mark, and retighten the screw.

(5.) Check that zeros of the one-speed dial and the 32-speed dial are aligned and that the 2 electrical zeroes are aligned with respect to each other and with respect to their respective dials.

CAUTION

This alignment must be conducted very carefully since a misalignment of even one degree on the single-speed shaft may result in faulty operation of the system.

(6.) After alignment is complete, remove the clip lead connecting the S1-S2 terminals of two resolvers.

6-55. OUT-THE-WINDOW DISPLAYS.

6-56. Calibration and adjustment of the out-the-window display equipment requires the combined skills of optics, electronics, and mechanics. The critical nature of the equipment demands that the most rigid procedures be followed for precise calibration and adjustment. In the case of optical assemblies, before any physical adjustments are made, the necessary steps for adjustment should be computed. Random or uncalculated adjustments should not be attempted as a lengthy delay could be caused which would postpone complete operation of the system.

6-57. LANDING WINDOWS.

6-58. Calibration and adjustment for the optical assemblies of each of the landing windows is identical, therefore only the procedure for one window is given. Although there are two optical paths, calibration for the complete window assembly is given as some of the elements have a dual use. Of the test fixtures, the telescope collimator array, the Wild pocket transit, and the auto-reflection targets should be checked before using.

6-59. OPTICAL PATH CALIBRATION. Calibration and adjustment should be conducted with reference to figures 6-12, 6-13 and 6-14, and in accordance with the following:

a. The point of intersection of the optical axis of each spherical mirror with the mirror surface must be indicated through use of small tabs. The tabs should be approximately 3/8" square, adhesive backed with cross lines on the front surface. The cross of the tab will identify the point of intersection of the optical axis of the spherical mirror with the mirror surface.

b. Removal of the faulty frame assembly and the corrector lens No. 1 should be conducted in accordance with the procedures set forth in Section IV. After installation of the corrected frame assembly but with corrector lens No. 1 and the covers still removed, check the air pressure in the system and adjust to 10 P.S.I. ±1 P.S.I. if required.

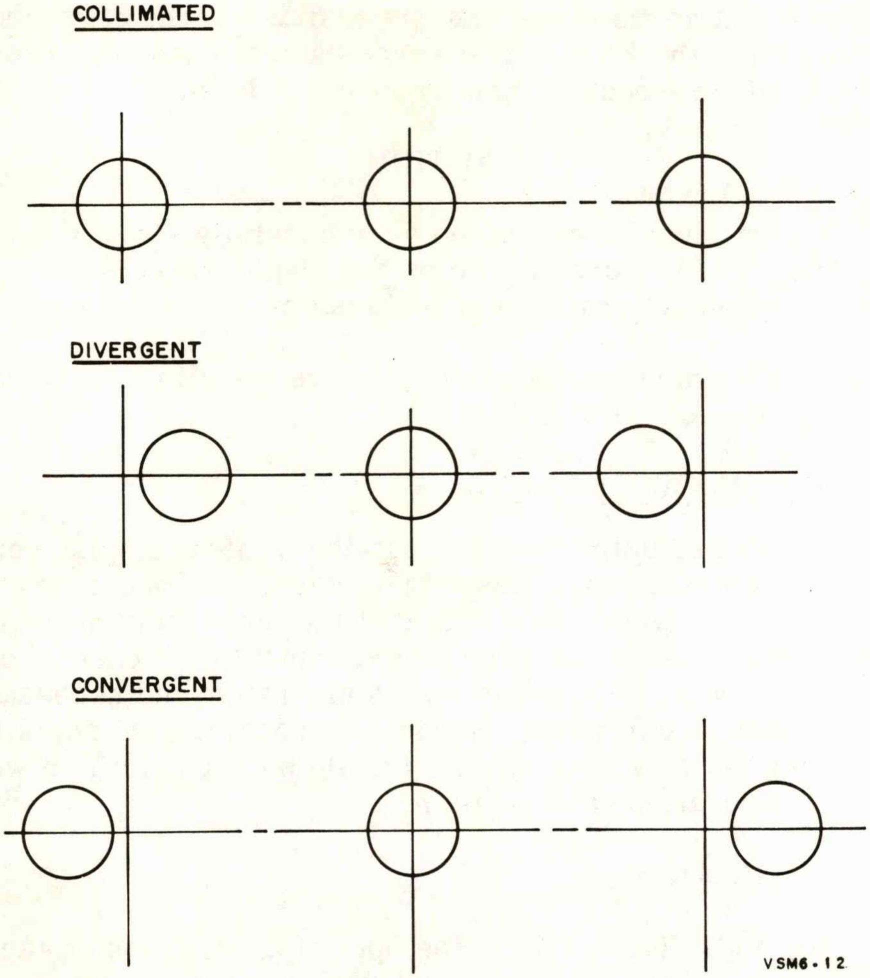


Figure 6-12. Telescope Focusing Conditions

c. Mount the adjustable target fixture at the center of curvature of the mirror No. 1 assembly as shown in figure 6-13. Adjust the cross wire target fixture to achieve coincidence of its cross with the center of curvature of mirror No. 1 Backlight the crosswires and position the target so that the reflected image is superimposed over the wires with a minimum of parallax.

d. Position the alignment telescope with optical square under the small crosswire target as shown in figure 6-13. Its function is that of establishing a line of sight between the center of curvature of the eyepiece and the point on the mirror surface through which the optical axis is intended to pass. This point is indicated on the mirror by the cross of 3/8 inch tab. Accomplish this by translating and rotating the alignment telescope to insure that both the crosswire target and the tab on the eyepiece mirror (mirror No. 1) are on the same line of sight. This line of sight is defined as the optical axis of the eyepiece mirror No. 1. Remove corrector lens No. 1 and install the sliding crosswire target fixture in its place. Adjust the lateral position and tilt of

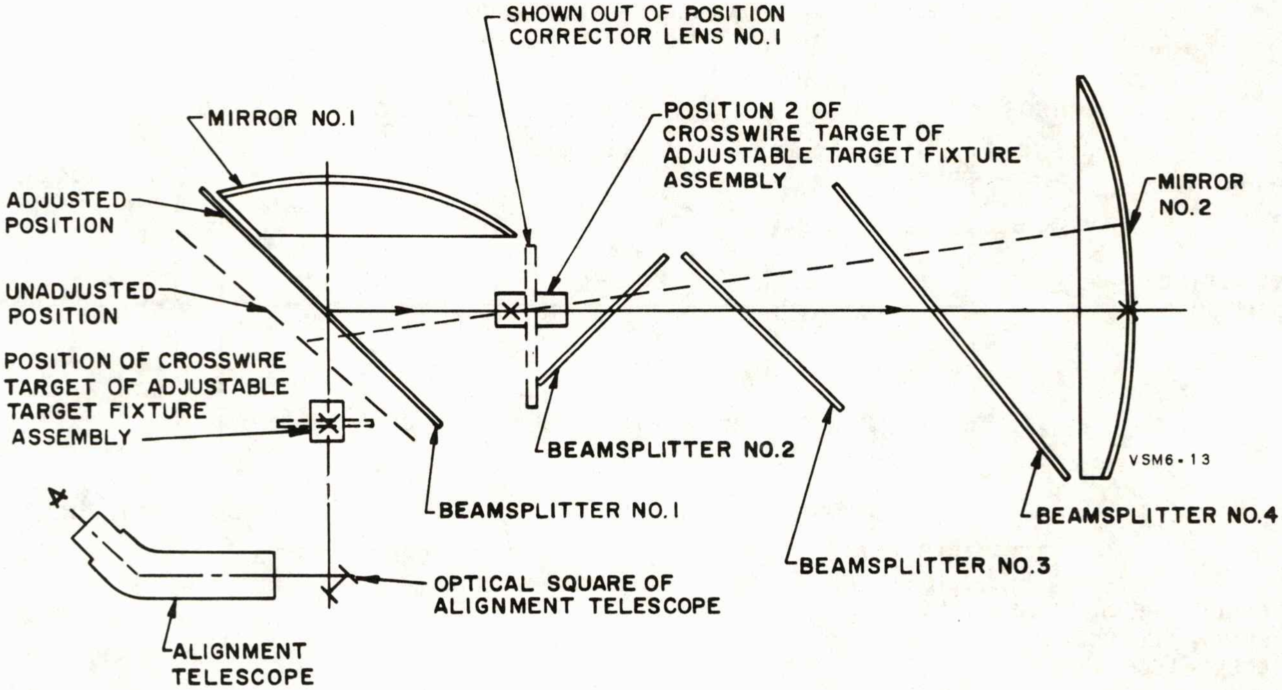
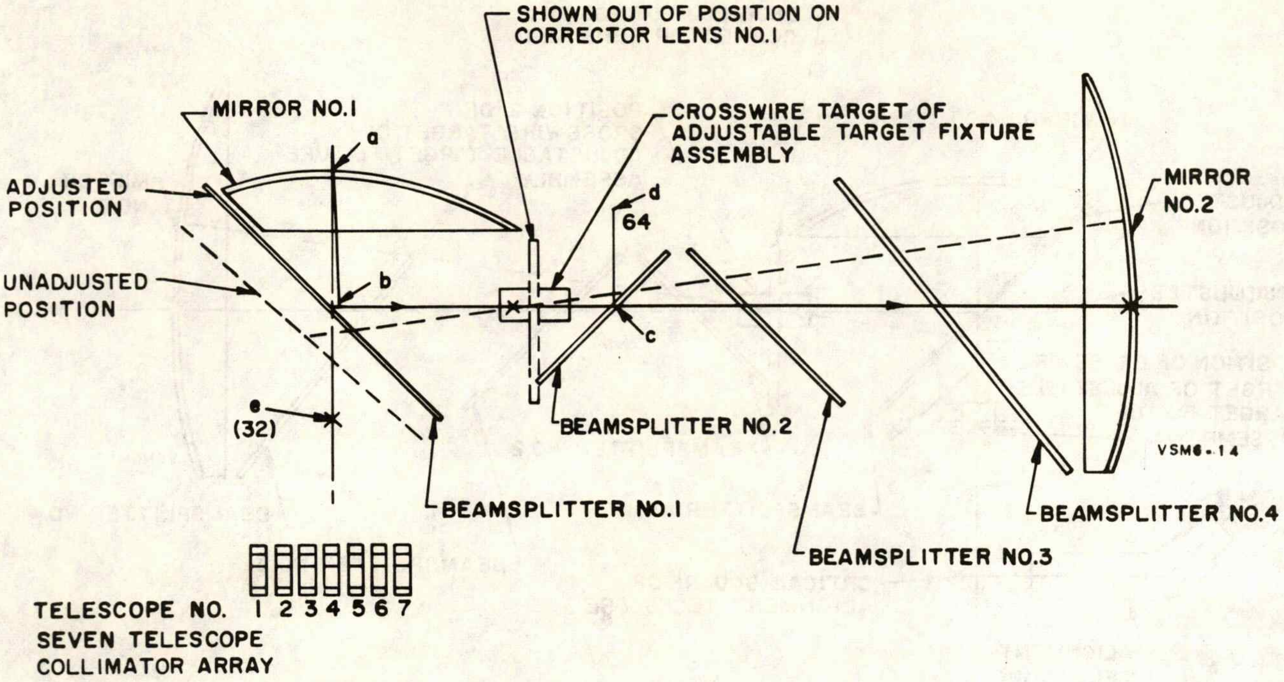


Figure 6-13. Position of Alignment Telescope and Adjustable Target During Window Calibration and Adjustment

the eyepiece beamsplitter (figure 6-13) so that the optical axis established by the above steps is projected through the crosswire target and the tag on the C/S relay mirror. The telescope should be re-focussed from one target to the other, but care must be exercised to maintain the telescope alignment. The eyepiece beamsplitter is considered adjusted when the reference marks on the eyepiece mirror center of curvature, eyepiece surface, adjustable target, and relay mirror surface are all collinear.

e. The purpose of the window tilting adjustment is that of tilting the relay mirrors No. 2 and 3 so that their centers of curvature coincide with and define the window optical axis. Backlight the adjustable target fixture and observe the image reflected by the celestial sphere mirror No. 2 Slide the tube of the adjustable target fixture, to reduce the parallax between the target and its image. Tilt the C/S mirror by inserting and rotating three over-point set screws (3/8 - 16 NC— THD 2 inches long) in the three taped holes of the perimeter of mirror assembly mounting frame. Continue this rotation as required to bring the image to the optical axis. The tab on the mission effects projector mirror (mirror No. 3) is adjusted to the same line of sight by tilting beamsplitter No. 4.

f. The same procedure is followed for the mission effects projector mirror (mirror No. 3). The optical axes of the relay mirrors No. 2 and 3 now coincide with the axis of the eyepiece mirror.



NOTE
DISTANCE a,b,c,d = 64"
DISTANCE a,b,c,d = 32"
CONJUGATE OF d WITH RESPECT TO MIRROR NO.1

Figure 6-14. Typical Position of Seven Telescope Collimator Array During Window Calibration and Adjustment

g. Remove the adjustable target fixture (figure 6-13) and install corrector lens No. 1.

h. Install the test fixture dummies, (celestial sphere fixture, and the MEP fixture).

i. Sight along the eyepiece mirror and celestial sphere mirror tabs and tilt beamsplitter No. 3 by adjusting the spline screws as required to center the celestial sphere field on this axis.

j. Repeat step i for the MEP path by adjusting beamsplitter No. 4.

k. The shape of the relay mirrors should be checked for uniformity. This is done by placing a small brilliant light source (a six-volt number 47 light will do) close to the center of curvature of the mirror. A small screen placed next to the light source will pick up the filament image formed by the entire surface of the mirror. This image should appear or be made to appear undistorted by removing mounting stresses if necessary. No more than one-quarter of an inch difference should exist between the far and near extremities

of the focused reflected image. However, caution should be taken so that the input image remains in line with both the eyepiece mirror tag, and the input mirror tag. If the alignment of the input is lost, the input beamsplitter must again be tilted to bring the input on axis again.

l. Center the seven telescope array in the exit pupil with the telescope objective positoned within a tolerance of plus or minus one-half inch of the correct exit pupil location. The correct exit pupil location can be located by placing a target, either permanent or temporary, 64 inches from the mirror at d of figure 6-14 and positioning the seven telescope collimator array at e (32 inches from a). Turn on the C/S system and by use of the telescope tilting adjustments, align the number four telescope (middle telescope of the seven) to the star generated by the C/S display. The star should appear in the same direction in each of the seven telescopes nearest the center of the field. Record the collimation errors in all telescopes for the horizontal and vertical pupil meridians. These errors will indicate either convergence or divergence of a beam which should be collimated. The error can be corrected by displacing the C/S or the 1/8 or 1/2 inch thick shims between the C/S bracket and the window frame as required to change the axial position of the sphere. When collimation at the center of the field is satisfactory, continue by taking similar measurements at 20 degrees up and down and 30 degrees left and right. If a field tilt is apparent from recorded data, the input beamsplitter must be laterally moved and tilted to normalize the condition. MEP collimation should be made similarly; however, a small amount of divergence is desirable so that this input will not appear more distant than the stars. Collimation readings of the inputs should be closely matched to have the superimposed images balanced. After each movement or adjustment, a complete set of collimation data must be taken throughout the field, and recorded readings again analyzed.

m. Mapping may be accomplished with the "Wild" pocket transit. Position the instrument at the center of the exit pupil and adjust the instrument so that the reticle follows both the vertical and horizontal test fixture axis evenly. The MEP test fixture indexs are nominally spaced five degrees apart. These are to be compared with readings measured from the pocket transit. The celestial sphere test fixture stars are spaced at exactly 2-1/2 degrees apart. The allowable tolerance of the mapping is one percent of the total angular measurement from center.

n. Before installing covers, all glass should be thoroughly vacuumed (with camel hair brush attachment), dusted, and cleaned as prescribed to insure the best possible images at the exit pupil.

6-60. CELESTIAL SPHERE ILLUMINATION FOR LANDING WINDOWS.

6-61. Optical calibration and adjustment procedures for the landing window celestial sphere illumination is quite similar to that of the rendezvous and docking windows. The optical path differs in that only one occulting assembly

is used. Refer to figure 6-15 for specific components referred to in the following procedure.

a. Check that the mounting collar is flush against the lamp and illuminate the lamp.

WARNING

Protective goggles (Bausch and Lomb, Ray Ban Type Z-301E) must be worn when observing the lamps and all exposed skin must be covered. Ultra-viloet rays of illumination can cause blindness and serious skin burns.

b. Remove cover and mirror assembly (1) and install a pinhole aperture at the position shown in the figure. Replace the cover and mirror assembly.

c. Remove cover and mirror assembly (2) and install a crosswire aperture at the position shown in the figure.

d. Center the pinhole aperture in relation to the crosswire by tilting the relay mirror nearest the light source. Replace cover and mirror assembly (2) behind crosswire target.

e. Remove the pinhole aperture and replace cover and mirror assembly (1).

f. Position calibration tapes on the illumination axis of the sphere which is 21 degrees 33 minutes from the roll axis of the sphere.

NOTE

The projected image from crosswire target should fall on the center of the tapes. This is accomplished by positioning the whole occultation and illumination frame but maintaining a distance of 55 inches from the source image to the sphere. This has been preset and dowel pins installed to secure the occultation and illumination frame to the main frame. Once dowels are installed, there should be no reason to readjust the alignment of the illumination and occultation frame. Therefore, care should be taken to replace dowels and shims if any, in original position if the units should ever be disassembled.

g. Install the baffle and field stop on the field lens assembly. Adjust the filed stop so that it is in the focal plane of the illumination source. Make sure that baffle and field stop are properly centered to achieve maximum brightness of image.

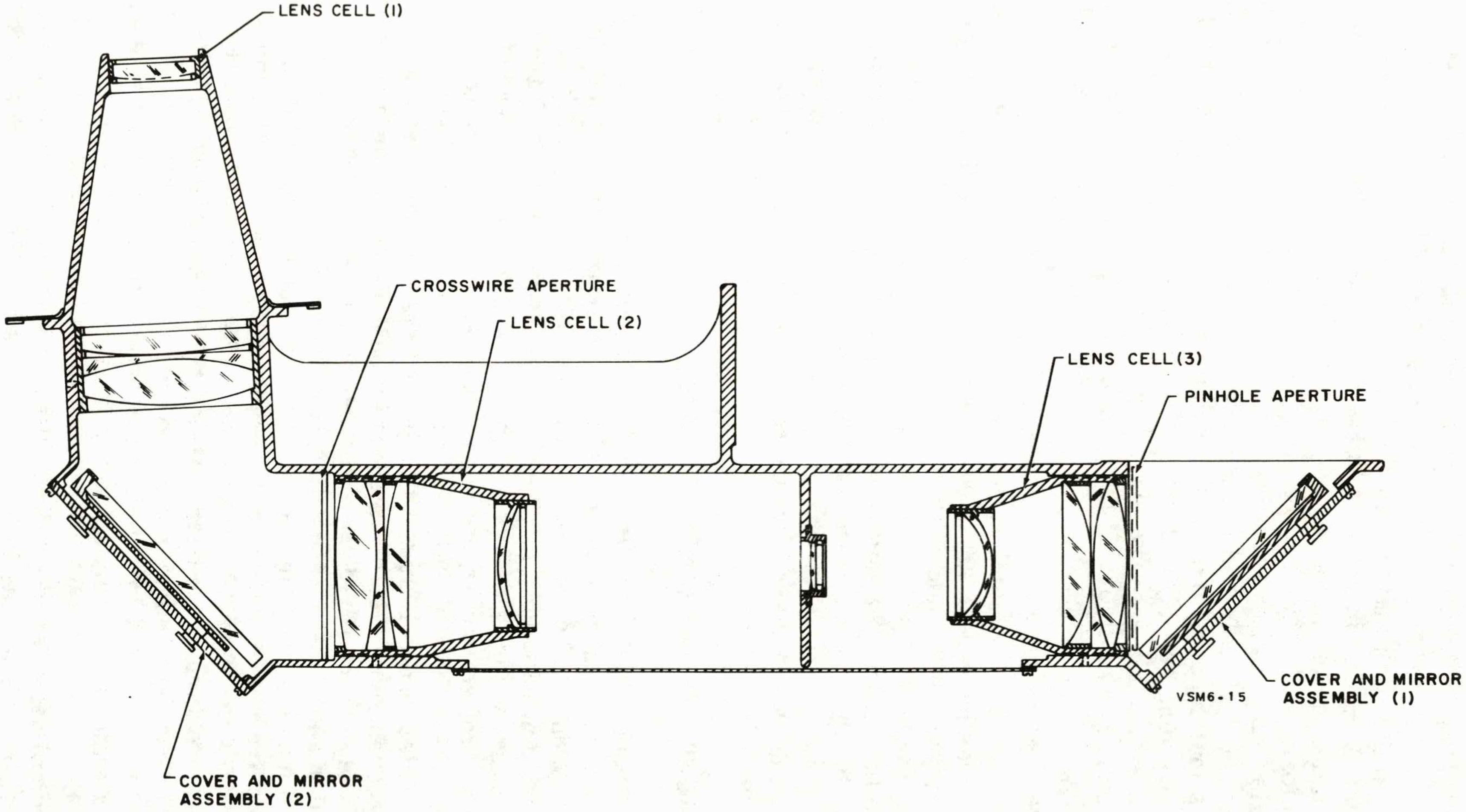


Figure 6-15. Landing Window C/S Illumination Path

h. Place a glass reticle, with concentric circle pattern, on the glass plate of the occultation unit. Position the reticle so that the projected circles are centered on the illumination axis. (The intersection of the tapes.) Observe the projected images in relation to the calibrated strips secured on the sphere. The markings on the tapes are spaced five degrees apart. The circles should conform to the five degree spacings in all four quadrants. If the projected circles are smaller than the five degree increments on the tapes, move lens (1) down. If the projected circles are larger, move lens (1) up. If the central circles match up but the outer circles are larger than the five degree markings, move lens cell (2) and lens cell (3) apart from each other. If the outer circles are smaller than five degree markings, move lens cell (2) and lens cell (3) toward each other. If the projected circles generally conform to the markings on the tapes, but are not in sharp focus, move lens cells (2) and (3) in the same direction.

i. Once all lenses have been adjusted, lock them securely in place by means of the set screws in the housings.

j. Secure the baffle plate in place and position the mask so that only 90 by 60 degree field is illuminated on the sphere.

k. Remove the dummy sphere, crosswire target, and reticle plate and install the actual celestial sphere.

6-62. RENDEZVOUS AND DOCKING WINDOWS.

6-63. Calibration and adjustment for the optical assemblies of each of the rendezvous and docking windows is identical, therefore only the procedure for one window is given. Although there are three optical paths, calibration for the complete window assembly is given as some of the elements have a dual use. Of the test fixtures, the telescope collimator array, the Wild pocket transit, and the auto-reflection targets should be checked before using.

6-64. The seven telescope collimator array is composed of seven small erect image telescopes spaced 1.75" apart and mounted upon a common baseplate. This assembly can be tilted about the vertical or elevation axis to subtend a particular angle with respect to a vertical plane. It also can be rotated about its horizontal axis or azimuth axis to subtend a particular angle with respect to a horizontal plane as required to allow the telescopes to sample any meridian of the pupil. Each telescope includes a reticle with vertical and horizontal divisons, with each division representing four minutes of true field. Each telescope includes individual azimuth and elevation adjusting screws. These are used to collimate all telescope axes with respect to each other prior to using the fixture for window alignment procedures.

6-65. Collimation of the telescopes is checked by sighting the tip of a smoke stack or utility pole at least a half mile distant. The individual

aximuth and elevation adjusting screws are then used to adjust the target image to the center of each reticle. An alternate method amploys a target plate which has a row of targets spaced 1.75" apart. The target plate can be viewed indoors from any distance exceeding 30 feet. Each telescope must then be aligned to its corresponding target. The adjusted telescope array can then be used at the exit pupil of the window simulator to determine the departure from true infinity focus. The center telescope is positioned at the center of the exit pupil and aligned to center the display image on the telescope reticle.

6-66. Infinity focus is indicated when the display image is zeroed on each reticle. Divergence is indicated when the end telescope images are focussed inwardly from the center. Convergence is indicated when the end telescope images are focussed outwardly from the center. Figure 6-12 illustrates these three conditions.

6-67. The "Wild" pocket transit is used to measure mapping errors. The characteristics of this telescope are:

Entrance pupil diameter	10 m.m.
Magnification	5 x
Elevation scan (prism)	±30°
Azimuth scan	360°

6-68. When measuring the mapping errors, the transit is positioned so that the elevation and azimuth axes cross at the center of the exit pupil. The axes must further be adjusted so that the reticle tracks along the meridian being measured. This means that when the telescope is adjusted, there will be no azimuth wander for elevation scanning and no elevation wander for azimuth scanning.

6-69. Elevation and azimuth scales provide direct readings to ten minutes of arc. Readings are estimated to one minute of arc. Measured data must be compared to the calibrated data provided for TV and MEP inputs. Measured data on the celestial shpere should be compared to the nominal angular values.

6-70. The auto-reflection targets are calibrated to measure displacement. Inaccruacies are found in the slip-on type of targets however, because the target normal may not coincide with the optical axis. This discrepancy is due to irregularities of the mating diameters. Corrections should be guided by the following considerations.

6-71. In auto-reflection, it is necessary to focus to the mirror and back to the target, i.e. if the mirror is 25 feet away, focus to 50 feet. When using a magnetic based mirror for auto-reflection, the mirror should be rotated 180 degrees after first taking a reading to determine if the mirror

is parallel with its magnetic base. If error prevails, adjustment should be made by correcting half the error in the surface. The reflection will then show equally on diametrically opposite sides of the cross hair.

6-72. The auto-reflection mirror must be set on the smooth, flat surface. If such a surface is not available, a good set of parallel blocks should be used between the mirror base and the surface being checked. The reflected image in auto-collimation is inverted. As the distance between instrument and target increases, the reflected image becomes more difficult to see. It is advantageous to have the mirror shaded from direct illumination.

6-73. OPTICAL PATH CALIBRATION. Calibration and adjustment should be conducted with reference to figures 6-13 and 6-14, and in accordance with the following:

a. The point of intersection of the optical axis spherical mirror with the mirror surface must be indicated through use of small tabs. The tabs should be approximately 3/8" square, adhesive backed with cross lines on the front surface. The cross of the tab will identify the point of intersection of the optical axis of the spherical mirror with the mirror surface.

b. Removal of the faulty frame assembly and the corrector lens No. 1 should be conducted in accordance with the procedures set forth in Section IV. After installation of the corrected frame assembly but with corrector lens No.1 and the covers still removed, check the air pressure in the system and adjust to 10 P.S.I. ±1 P.S.I. if required.

c. Mount the adjustable target fixture at the center of curvature of the mirror No. 1 assembly as shown in figure 6-13. Adjust the cross wire target fixture to achieve coincidence of its cross with the center of curvature of mirror No. 1. Backlight the crosswires and position the target so that the reflected image is superimposed over the wires with a minimum of parallax.

d. Position the alignment telescope with optical square under the small crosswire target as shown in figure 6-13. Its function is that of establishing a line of sight between the center of curvature of the eyepiece and the point on the mirror surface through which the optical axis is intended to pass. This point is indicated on the mirror by the cross of the 3/8 inch tab. Accomplish this translating and rotating the alignment telescope to insure that both the crosswire target and the tab on the eyepiece mirror (mirror No. 1) are on the same line of sight. This line of sight is defined as the optical axis of the eyepiece mirror No. 1. Remove corrector lens No. 1 and install the sliding crosswire target fixture in its place. Adjust the lateral position and tilt of the eyepiece beamsplitter (see figure 6-13) so that the optical axis established by the above steps is projected through the crosswire target and the tag on the C/S relay mirror. The telescope should be re-focussed from one target to the other, but care must be exercised to

maintain the telescope alignment. The eyepiece mirror center of curvature, eyepiece surface, adjustable target and relay mirror surface are all collinear.

e. The purpose of the window tilting adjustment is that of tilting the relay mirrors No. 2, 3, and 4 so that their centers of curvature coincide with and define the window optical axis. Backlight the adjustable target fixture and observe the image reflected by the celestial sphere mirror No. 2 Slide the tube of the adjustable target fixture, to reduce the parallax between the target and its image. Tilt the C/S mirror by inserting and rotating three over-point set screws (3/8 - 16 NC - THD 2 inches long) in the three taped holes of the perimeter of mirror assembly mounting frame. Continue this rotation as required to bring the image to the optical axis. The tab on the mission effects projector mirror (mirror No. 4) is adjusted to the same line of sight by tilting beamsplitter No. 3.

f. The same procedure is followed for the TV mirror (mirror No. 3) and the mission effects projector mirror (mirror No. 4). The optical axes of the relay mirrors No. 2, 3, and 4 now coincide with the axis of the eyepiece mirror.

g. Remove the adjustable target fixture (figure 6-13) and install corrector lens No. 1.

h. Install the test fixture dummies, (TV fixture celestial sphere fixture and the MEP fixture).

i. Sight along the eyepiece mirror and celestial sphere mirror tabs and tilt beamsplitter No. 4 by adjusting the spline screws as required to to center the celestial sphere field on this axis.

j. Repeat step i for the TV path by adjusting beamsplitter No. 5.

k. Repeat step i for the MEP path by adjusting beamsplitter No. 6.

l. The shape of the relay mirrors should be checked for uniformity. This is done by placing a small brilliant light source (a six-volt number 47 light will do) close to the center of curvature of the mirror. A small screen placed next to the light source will pick up the filament image formed by the entire surface of the mirror. This image should appear or be made to appear undistorted by removing mounting stresses if necessary. No more than one-quarter of an inch difference should exist between the far and near extremities of the focused reflected image. However, caution should be taken so that the input image remains in line with both the eyepiece mirror tag, and the input mirror tag. If the alignment of the input is lost, the input beamsplitter must again be tilted to bring the input on axis again.

m. Center the seven telescope array in the exit pupil with telescope objective positioned within a tolerance of plus or minus one-half inch of the correct exit pupil location. The correct exit pupil location can be located by placing a target, either permanent or temporary, 64 inches from the mirror at d of figure 6-14 and positioning the seven telescope collimator array at e (32 inches from a). Turn on the C/S system and by use of the telescope tilting adjustments, align the number four telescope (middle telescope of the seven) to the star generated by the C/S display. The star should appear in the same direction in each of the seven telescopes nearest the center of the field. Record the collimation errors in all telescopes for the horizontal and vertical pupil meridians. These errors will indicate either convergence or divergence of a beam which should be collimated. The error can be corrected by displacing the C/S or the 1/8 or 1/2 inch thick shims between the C/S bracket and the window frame as required to change the axial position of the sphere. When collimation at the center of the field is satisfactory, continue by taking similar measurements at 20 degrees up and down and 30 degrees left and right. If a field tilt is apparent from recorded data, the input beamsplitter must be laterally moved and tilted to normalize the conditon. TV and MEP collimation should be made similarly; however, a small amount of divergence is desirable so that these inputs will not appear more distant than the stars. Collmination readings of the inputs should be closely matched to have the superimposed images appear balanced. After each movement or adjustment, a complete set of collimation data must be taken throughout the field, and recorded readings again analyzed.

n. Mapping may be effected with the "Wild" pocket transit. Position the instrument at the center of the exit pupil and adjust the instrument so that the reticle follows evenly both the vertical and horizontal test fixture axis. The MEP and TV test fixture indicies are norminally spaced five degrees apart. These are to be compared with readings measured from the pocket transit. The celestial sphere test fixture stars are spaced at exactly 2-1/2 degrees apart. The allowable tolerance of the mapping is one percent of the total angular measurement from center.

o. Before installing covers, all glass should be thoroughly vacuumed (with camel hair brush attachment), dusted, and cleaned as prescribed to insure the best possible images at the exit pupil.

6-74. CELESTIAL SPHERE ILLUMINATION FOR RENDEZVOUS AND DOCKING WINDOWS.

6-75. Optical calibration and adjustment of the celestial sphere illumination system for the rendezvous and docking windows is accomplished as follows: (See figure 6-16).

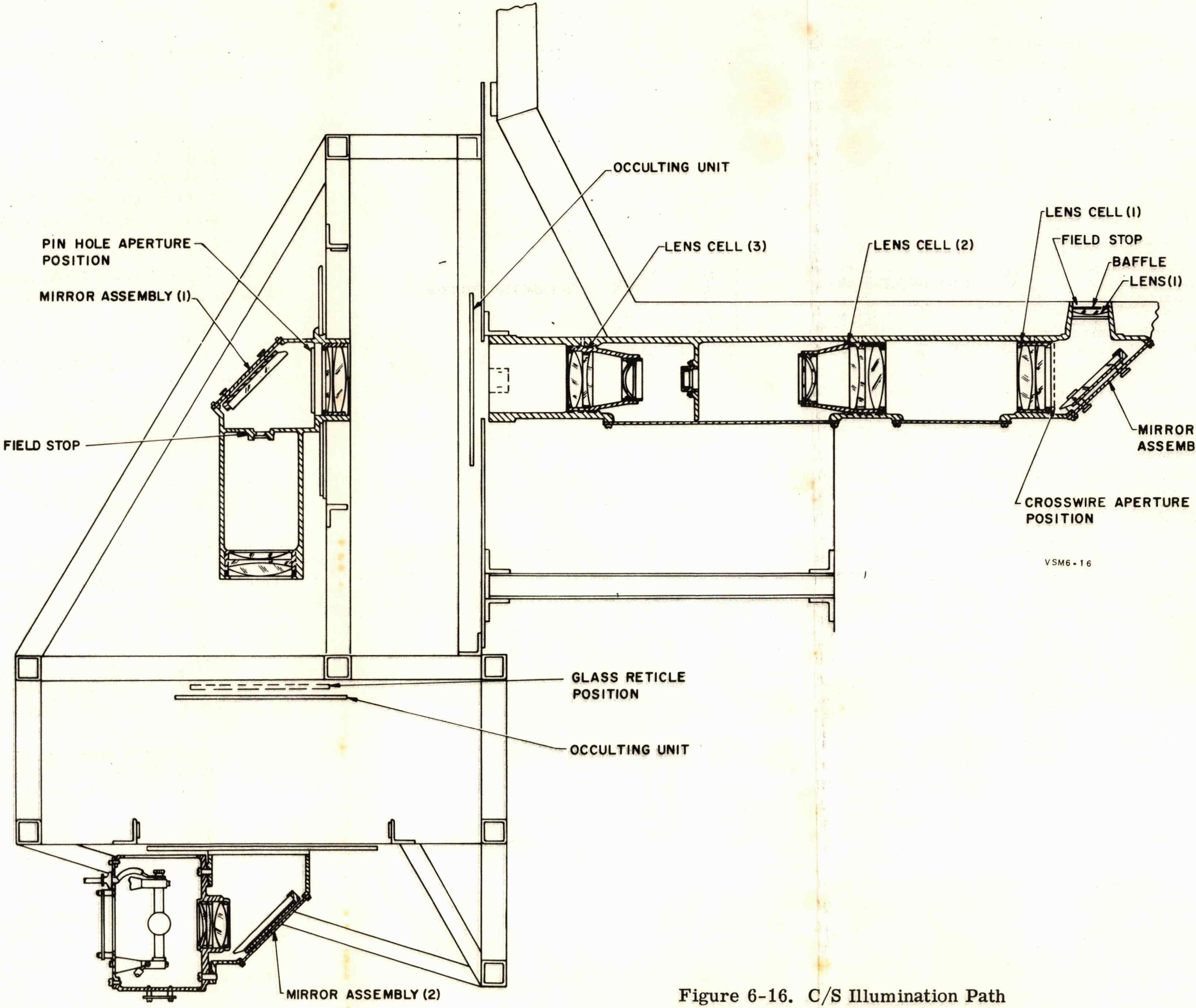


Figure 6-16. C/S Illumination Path

a. Check that the mounting collar is flush against the lamp and illuminate the lamp.

WARNING

> Protective goggles (Bausch and Lomb, Ray Ban Type Z-301E) must be worn when observing the lamps and all exposed skin must be covered. Ultra-violet rays of illumination can cause blindness and serious skin burns.

b. Remove cover and mirror assembly (1) and install a pinhole aperture at the position shown in the figure.

c. Sight down the relay assembly and position the image of arc at the center of the field by tilting mirror assembly (2). Replace cover and mirror assembly (1).

d. Remove cover and mirror assembly (3) and install a crosswire aperture at the center lens cell as shown in the figure.

e. Center the pinhole aperture in relation to the crosswire by tilting mirror (1) and replace cover and mirror assembly (3).

f. Remove the pinhole aperture and replace the mirror. Position calibration tapes on the illumination axis of the sphere which is 19 degrees 45 minutes from the roll axis of the sphere.

NOTE

> The projected image from crosswire target should fall on the center of the tapes. This is accomplished by positioning the whole occultation and illumination frame but maintaining a distance of 55 inches from the source image to the sphere. This has been preset and dowel pins installed to secure the occultation and illumination frame to the main frame. Once dowels are installed, there should be no reason to readjust the alignment of the illumination and occultation frame. Therefore, care should be taken to replace dowels and shims if any, in original position if the units should ever be disassembled.

g. Install the baffle and field stop on the field lens assembly. Adjust the field stop so that it is in the focal plane of the illumination source. Make sure that baffle and field stop are properly centered to achieve maximum brightness of image.

h. Place a glass reticle, with concentric circle pattern, on the glass plate of the occultation unit. Position the reticle so that the projected circles are centered on the illumination axis. (The intersection of the tapes.) Observe the projected images in relation to the calibrated strips secured on the sphere. The markings on the tapes are spaced five degrees apart. The circles should conform to the five degree spacings in all four quadrants. If the projected circles are smaller than the five degree increments on the tapes, move lens (1) down. If the projected circles are larger, move lens (1) up. If the central circles match up but the outer circles are large than the five degree markings, move lens cell (2) and lens cell (3) apart from each other. If the outer circles are smaller than five degree markings, move lens cell (2) and lens cell (3) toward each other. If the projected circles generally conform to markings on the tapes, but are not in sharp focus, move lens cells (2) and (3) in the same direction.

i. Once all lenses have been adjusted, lock them securely in place by means of the set screws in the housings.

j. Secure the baffle plate in place and position the mask so that only a 105 by 80 degree field is illuminated on the sphere.

k. Remove the dummy sphere crosswire target and reticle plate and install the actual celestial sphere.

6-76. CELESTIAL SPHERE.

6-77. Calibration of the celestial sphere is accomplished by zeroing the yaw, pitch and roll resolvers as outlined in the following paragraphs. When zeroing of the pitch axis is performed, disassembly of the celestial sphere sourthern hemisphere is required to gain access to the pitch resolver (refer to Section IV, Removal and Installation, paragraph 4-64 for C/S disassembly instructions).

6-78. INDEXING AND ZEROING PROCEDURE. Indexing and zeroing of the pitch, yaw, and roll axis is accomplished as follows:

a. On test panel IA19 in the electronics racks, No. 70, 71, 72, 73 and 10, set the celestial sphere pitch, yaw and roll axes mode selector switches to the "MANUAL" position.

b. Set the pitch, yaw and roll axes manual mode resolvers to "0" on their respective dials and lock them in that position.

c. With all the power in the "on" mode the celestial sphere assembly will rotate and settle out with the respective index marks on the three axes aligned.

d. After replacing a resolver rotate the resolver case until the servo positions the celestial sphere in such a way as to align the index marks (see figure 6-17 and 6-18) on the corresponding axis.

e. Lock the resolver in this position.

f. Reset the celestial sphere pitch, yaw and roll axes mode selector switches on test panel IA19 to the "AUTO" position.

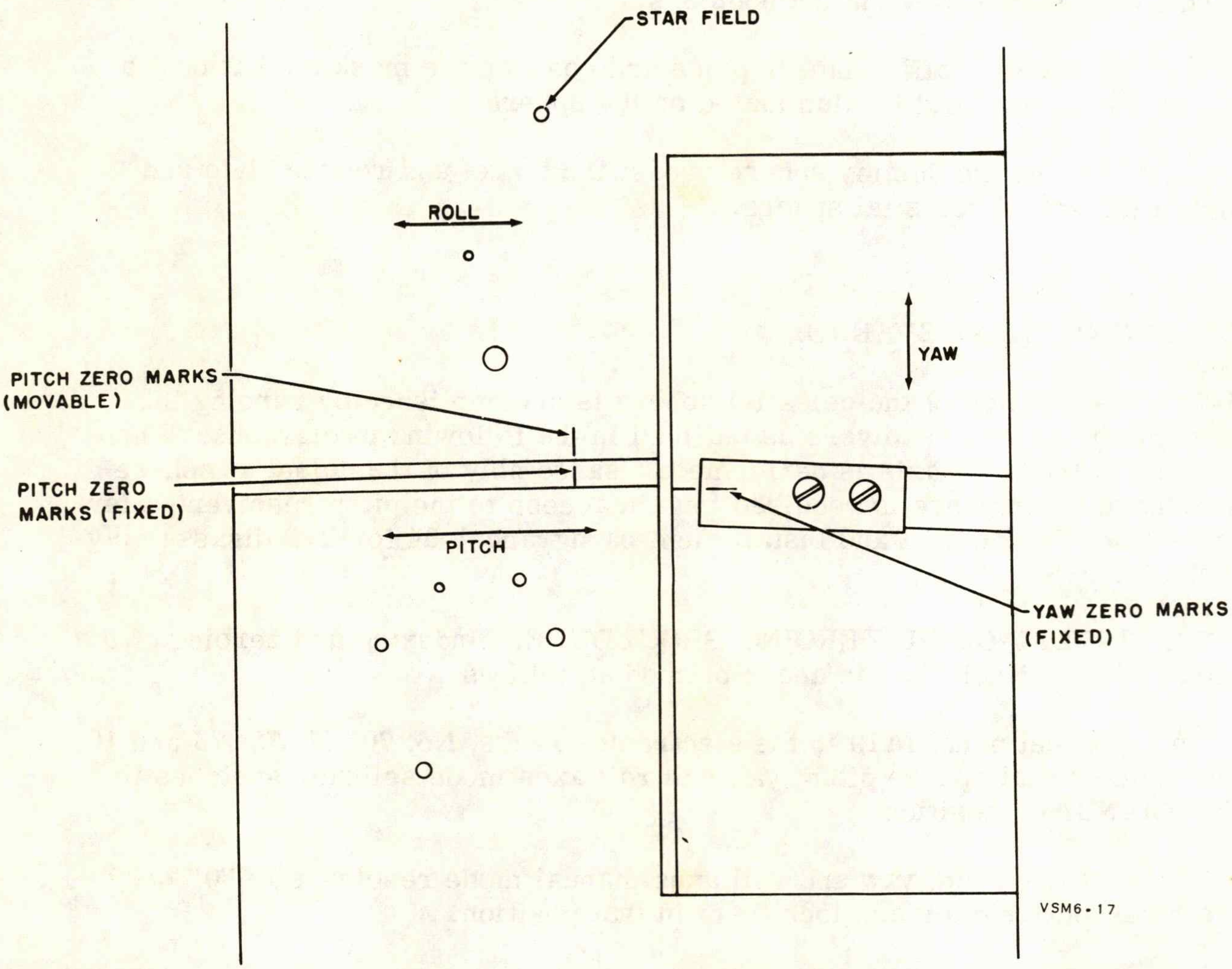


Figure 6-17. C/S Yaw and Pitch Axes Zero Marks

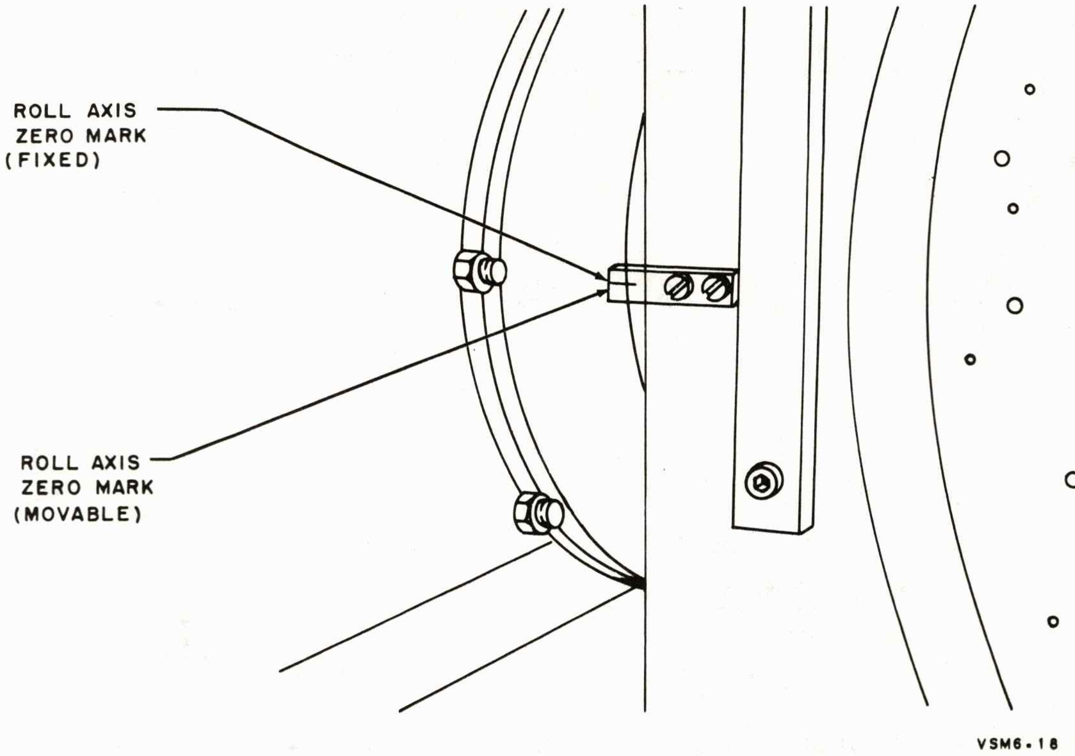


Figure 6-18. C/S Roll Axis Zero Marks

6-79. SERVO SYSTEM DAMPING ADJUSTMENT. (See figure 6-19.) The following procedure is recommended for servo system adjustment after replacement of a resolver. Connect the oscilloscope (item 21, table 6-1) in sequence to terminals (7-9) of the preamplifier and demodulator "AR1 (roll), AR2 (pitch) and AR5 (yaw)". The roll, yaw, and pitch axes servo systems should have one overshoot for small displacements from any position. For large displacements from any position, approximately six to ten overshoots should be observed. Adjust "ROLL GAIN ADJUST R1", "PITCH GAIN ADJUST R3", and "YAW GAIN ADJUST R5" or "ROLL TACH. ADJUST R2", "PITCH TACH. ADJUST R4", and "YAW TACH. ADJUST R6" until the required number of overshoots is produced for small displacements of the input command test resolver on test panel IA19.

6-80. C/S SERVO SYSTEM POTENTIOMETER ADJUSTMENTS. The following is a list of the nominal settings of potentiometer controls. Small variations from these positions may have been imposed upon final check out of the servo systems. The following resistance values are measured from the arm to the low side, or from terminal 2 to terminal 3 with the potentiometer unloaded.

a. Roll axis gain adjust - R1 3.5K ohms

b. Roll axis tach. adjust - R2 - 600K ohms

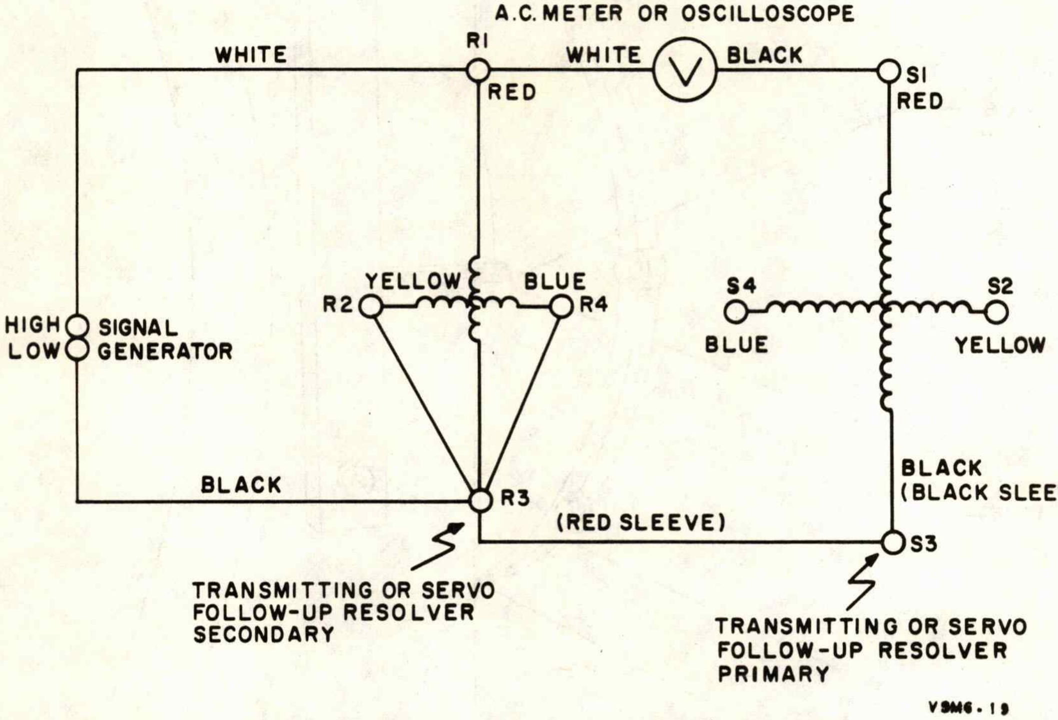


Figure 6-19. Electrical Connections for C/S Resolver Zeroing

c. Pitch axis gain adjust - R3 - 20K ohms

d. Pitch axis tach. adjust - R4 - 200K ohms

e. Yaw axis gain adjust - R5 - 20K ohms

f. Yaw axis tach. adjust - R6 - 130K ohms

g. SSI power amplifier gain selector switch set to 100.

6-81. HIGH-POWER D-C AMPLIFIER (SSI).

6-82. The balance adjustment procedure for the high-power d-c amplifier is as follows:

a. Connect the amplifier to line power and allow 30 minutes for warm-up.

b. Connect a short circuit into the input front panel test points.

c. With the meter selector in the "10V" position and the gain selector in the "200" position, a full scale deflection on the meter corresponds to an offset of 50 millivolts referred to the input of the amplifier.

d. Adjust the balance control to be arbitrarily close to zero as measured on the front panel.

e. The amplifier is now balanced and ready for operation.

6-83. For d-c operation, the load resistor should be measured to ascertain that the output characteristics of the amplifier are compatible with the power required. The level and balance adjustment procedure is as follows:

a. Insert a short into the front panel input test jacks.

b. Set the meter selector and gain selector to their maximum sensitivity for which the meter reading will stay on scale.

c. Connect a d-c multimeter (item 19, table 6-1) between the positive terminal of the output voltage test point and the ground terminal of the input test jack.

d. Adjust the balance adjust control below the front panel meter for zero reading on the panel meter.

e. Adjust the level control, R64, for a zero reading on the multimeter.

f. Repeat steps d. and e. while increasing the sensitivity of the meter reading until both meters read zero volts dc.

6-84. For portection circuit adjustment of the amplifier proceed as follows:

a. Rotate potentiometer R63 to the maximum counterclockwise position.

b. Connect a load of five ohms to the amplifier output.

c. Connect a d-c signal source to the input test jacks on the front panel.

d. Turn the amplifier "on" and increase the output voltage for an output current of 11 amperes.

e. Turn potentiometer R63 countercloskwise until the protection circuit trips out the circuit breaker.

f. Repeat step d. as a check on protection circuit set point.

g. Reverse the polarity of the input signal and repeat step d. to assure that the set point is approximately 11 amperes in the opposite polarity.

6-85. MISSION EFFECTS PROJECTOR.

6-86. Calibration of the mission effects projector is limited to sub unit calibration of the non-pinned subassemblies.

6-87. MISSION FILM AND TRANSBOUNDARY LAMP ASSEMBLY. Calibration of the mission film lamp assembly is broken down into subassembly calibration procedures and is accomplished as follows:

NOTE

Item numbers refer to figure 4-13.

6-88. Condenser Lens. Calibration and adjustment of the mission film lamp assembly following installation of lenses is to be conducted with the mission film lamp assembly removed from the MEP and in accordance with the following procedures.

a. Remove cover (2), by removing cover securing screws (1).

b. Align an auxiliary high intensity (Tensor) lamp (see table 6-1) to illuminate the mission film lamp assembly arc lamp electrodes as shown by figure 6-20.

c. Measure distance of lamp electrode image from the forward apex of lens (item 17). This distance should measure 686 m/m. If distance other than this is measured, change thickness of shims (24) as required to achieve a 686 m/m image distance. A change in shim distance changes the distance from the arc lamp to the mirror. Correct mirror position by focusing the mirror cell in or out by rotating the left hand extremity of the mirror support assembly (18) until indirect and reflected images appear as shown on figure 6-20.

6-21

d. Replace cover (2) and secure with cover screws (1).

e. Reinstall the mission film lamp assembly in the MEP according to paragraph 4-74.

f. After reinstallation of the entire non-pinned mission film lamp assembly in the MEP remove the relay lens No. 1 assembly collimator. Removal of this unit is accomplished by removing the three securing bolts in the lens assembly legs. Index the quick dissolve mirror assembly to direct arc lamp illumination through turret No. 1. Align a mirror with the aperture of distortion lens I assembly and view the direct and reflected images of the laterally illuminated lamp electodes (see figures 6-20 and 6-21) and the lens aperture.

g. If images are not centered within the aperture as illustrated by figure 6-16 loosen (but do not remove) the mission film lamp assembly collar mounting bolts and associated fasteners and center images by adjusting the four mission film lamp assembly collar alignment screws as required to achieve this degree of centering. This operation completes rough or approximate adjustment.

h. Conduct illumination uniformity measurements at the MEP screen assembly by adjusting the mission film lamp assembly collar adjust screws as required to optimize screen illumination uniformity.

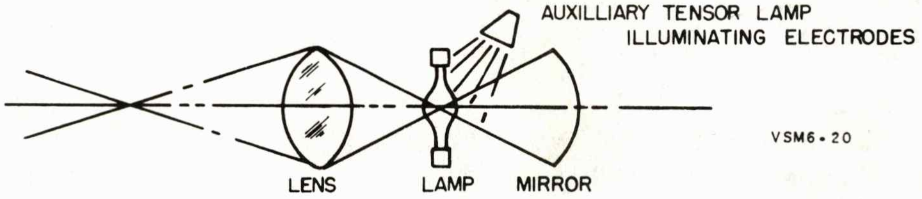
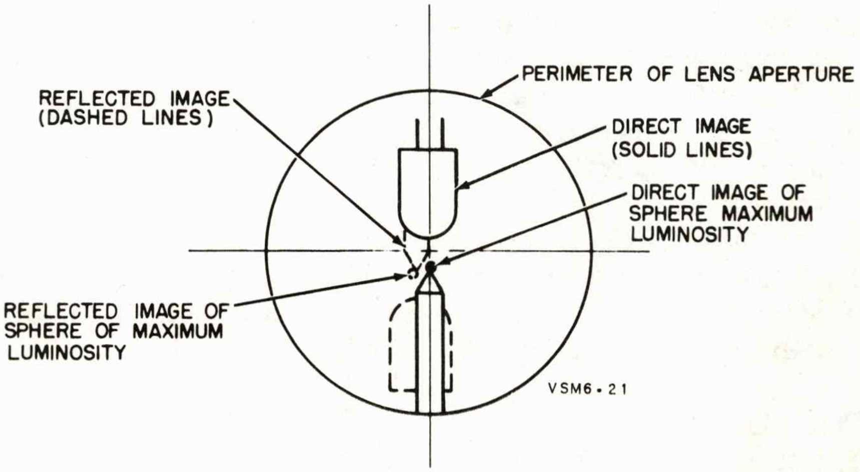


Figure 6-20. Tensor Lamp Test Setup



NOTE: COINCIDENCE OF DIRECT AND REFLECTED IMAGE WILL MELT ELECTRODE TIP

Figure 6-21. Arc Lamp Replacement

6-89. Mirror Assembly. Calibration and adjustment following installation of the mirror support assembly (18) is to be conducted with the mission film lamp assembly removed from the MEP and in accordance with the following procedures.

a. Remove cover (2) by removing cover securing screws (item 1).

b. Align an auxiliary high intensity (Tensor) lamp (see table 6-1) to illuminate the mission film lamp assembly arc lamp electrodes as shown in figure 6-20 and 6-21.

c. Focus the mirror support by rotating the left hand extremity of the mirror support assembly (18) until the direct and reflected images appear as shown on figure 6-21.

d. Replace cover (2) and secure with cover screws (1).

e. Reinstall the mission film lamp assembly into the MEP according to paragraph 4-74.

f. After reinstallation of the entire non-pinned mission film lamp assembly in the MEP, remove the relay lens No. 1 assembly collimator. Removal of this unit is accomplished by removing the three securing bolts in the lens assembly legs. Index the quick dissolve mirror assembly to direct arc lamp illumination through turret No. 1. Align a mirror with the aperture of distortion lens I assembly and view the direct and reflected images of the laterally illuminated lamp electrodes (see figure 6-20 and 6-21) in the lens aperture.

g. If images are not centered within the aperture as illustrated by figure 4-16 loosen (but do not remove) the mission film lamp assembly collar mounting bolts and associated fasteners and center images by adjusting the four mission film lamp assembly collar alignment screws as required to achieve this degree of centering. This operation completes rough or approximate adjustment.

h. Conduct illumination uniformity measurements at the MEP screen assembly by adjusting the mission film lamp assembly collar adjusting screws as required to optimize screen illumination uniformity.

6-90. TRANSBOUNDARY ILLUMINATION ASSEMBLY. Calibration of the transboundary illumination assembly is broken down in subassembly calibration procedures and is accomplished as follows.

NOTE

Item numbers refer to figure 4-13.

6-91. Condenser Relay Mirrors. Calibration of the transboundary illumination assembly following replacement of the condenser relay mirror is accomplished as follows:

a. Light the lamp electrode with a Tensor lamp. (See figure 6-20.)

b. Hold a small mirror at 45°, with respect to the optical axis at the upper transboundary illumination assembly aperture.

c. Align the mirrors by means of shims placed under their fasteners to achieve centering of the direct and reflected electrode images in the aperture.

d. Ignite the lamp.

e. Check the uniformity of illumination on the screen assembly. (See figure 6-21.)

f. Adjust shims under mirror fasteners as required to obtain optimum uniformity of illumination.

6-92. EXTENDED OFF COURSE ASSEMBLY. Calibration of the extended off course assembly is accomplished with the unit removed from the MEP, and in accordance with the following procedures.

NOTE

Item numbers refer to figure 4-19.

a. Bolt the extended off-course assembly to the surface plate.

b. Square a graduated reticle collimating telescope with the fixed mirror (item 10) by auto-collimation.

c. Adjust X axis drive of telescope, as required, to achieve centering of the center of the fixed mirror perture with the center fiducial mark of the telescope.

6-93. ATTITUDE ASSEMBLY. Calibration of the attitude assembly is accomplished as follows:

a. Calibration, to be performed after installation of the collimator lens assembly, is described below.

1. Measure and record the mounting flange-to apex distance of the original assembly.

2. Adjust the mounting flange-to apex distance of the replacement assembly to the distance measured on the original assembly.

b. Calibration procedures for focusing of collimator lens assembly, after installation are listed below.

1. Place film reticle in film gate of the indexed cassette of either turret I or II.

2. Turn on mission film lamp assembly.

3. Observe the focus on the screen (P/N 117636).

4. Adjust the focus as follows:

(a) Release set screw.

(b) Turn lens assembly cell until a sharp image is achieved.

(c) Lock set screw.

6-94. TERMINATOR AND TERMINATOR ROTATOR. Calibration of the terminator and terminator rotator assembly is broken down into subassembly calibration, and is accomplished as follows.

6-95. Meniscus Lens and Terminator focal Plane Plate.

a. Calibration procedures for replacement of the meniscus lens are listed below.

1. Using a depth gauge, measure flange to concave apex distance of the old or damaged lens, if condition of lens permits this.

2. On replacing the lens, insert a shim as required to achieve flange to apex distance, identical to that measured in the previous step.

b. Calibration procedures following replacement of the meniscus lens are listed below.

1. Turn on trans-boundary lamp assembly lamp and check focus at screen.

2. Trim focus as follows:

(a) Release set screw.

(b) Rotate collimator lens assembly as required, to achieve a sharp focussed, MEP screen image.

6-96. SOLAR IMAGE ASSEMBLY. Calibration of the solar image assembly is accomplished as follows:

NOTE

Item numbers refer to figure 4-22.

a. Remove brackets (4) and shield (8) as stated in 4-100.

b. Align a Tensor high intensity lamp (refer to table 6-1) to illuminate lamp electrodes (figure 6-20).

c. Measure space between the field stop housing (16) and lamp housing (25) with feeler gage.

d. Position and focus a dioptometer (refer to table 6-1) on the field stop aperture - note the reading.

e. Unscrew the field stop housing.

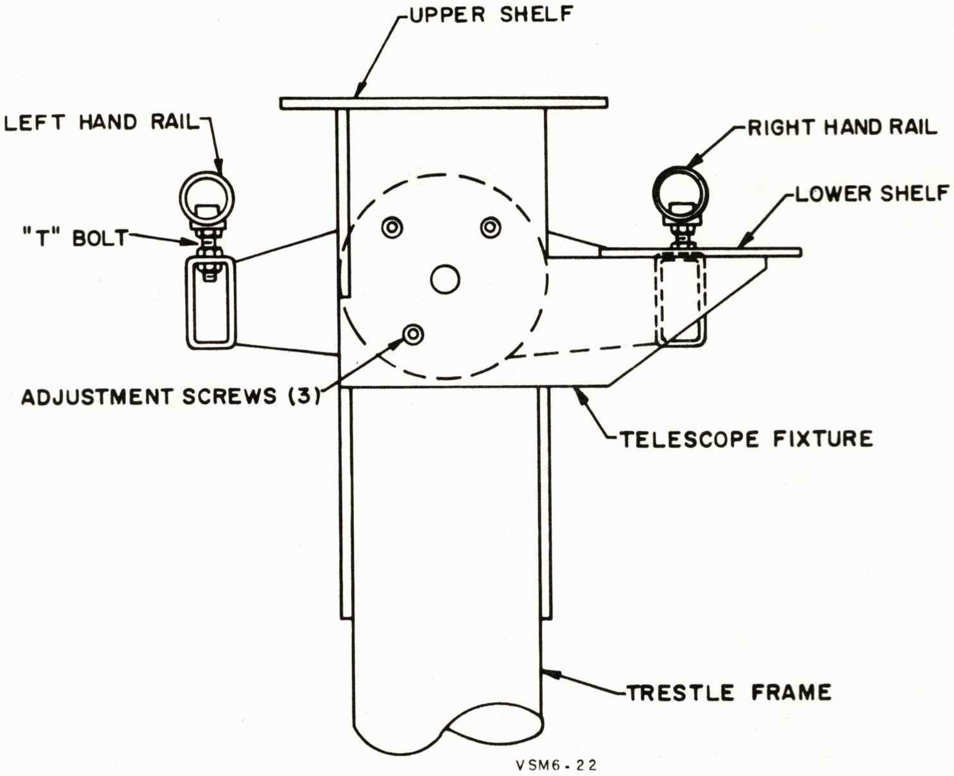


Figure 6-22. Platform Fixture Mounting Position

f. The prime electrode image should be in focus, after the dioptometer has been focussed on it.

g. Focus the dioptometer on the reflected image.

h. Adjust the reflected image by:

1. Loosen screws (27) and lockwashers (28).
2. Adjust hex set screws until reflected image is in focus.
3. Tighten screws (27).

i. Replace shield and brackets and reinstall the assembly back in the MEP.

6-97. Condensing Lens. Calibration of the solar image condensing lens is accomplished using the parallex method of mirror alignment as follows:

a. Check the condensing mirror for image centering. (See figure 6-20.)

b. Adjust the mirror by turning set screw (20) and mirror cell together, in either direction, as required to achieve image centering.

6-98. Arc Lamp. Calibration of the solar arc lamp is accomplished by using the same general procedures as described for the mission film and transboundary arc lamps.

6-99. PROJECTION SCREEN ASSEMBLY. Calibration of the projection screen assembly is accomplished as follows:

a. Place a film reticle in the film gate of the indexed cassette of either turret I or II.

b. Turn on the mission film lamp assembly.

c. Check focus on the screen assembly.

d. To focus, turn the knurled flange on the projection lens until image on the screen is sharp.

6-100. MISSION EFFECTS PROJECTOR POWER SUPPLIES.

6-101. Calibration and adjustment procedures of the MEP power supplies, other than the normal front panel adjustments, are limited to a high voltage adjustment and an amplifier balance. As the procedure and circuitry for all MEP power supplies is similar, only the procedures for the mission film power supply are given.

a. High Voltage Adjustment. The high-voltage is adjusted as follows:

1. Variable resistor (R21) is nominally adjusted to provide 80 to 90 volts output for starting the average arc lamp. This voltage can be increased to provide a higher voltage for starting weak arc lamps.

2. Employing a three-phase power source, reduce the input voltage to 186 volts (low power line). Loosen the thumbscrew on the slide arm of variable resistor (R21) and adjust for a voltage output of 80 to 90 volts.

NOTE

When adjusting the output for weak lamps, the voltage output may be adjusted to as high as 120 volts.

b. Amplifier Balance. To balance the dual differntial amplifier:

1. Variable resistors (R17 and R22) provide balance reference signals to the dual differential amplifier. These controls are adjusted at the factory and should not be tampered with unless they are defective and must be replaced.

2. Variable resistor (R17) controls hunting and overshooting of the powerstat. The resistor is adjusted so that the reading on the OUTPUT CURRENT meter will agree with the setting of the CURRENT ADJ control.

3. Variable resistor (R22) controls output current during the start sequence. The voltage at the arm of this resistor should be approximately 1.2 volts dc during the start or ignite period.

6-102. RENDEZVOUS IMAGE GENERATION EQUIPMENT.

6-103. Alignment, both electrical and mechanical, is of prime importance in the rendezvous image generation system equipment. In order to properly simulate the conditions and actions of the target vehicle with respect to the command module, critical measurements must be maintained. In most cases, visual observation through the window of the command module will show that an alignment or adjustment is required. If it is determined that an alignment or adjustment is required, follow the procedures in the following paragraphs.

6-104. TRESTLE ASSEMBLY.

6-105. The adjustment of the trestle assembly is very critical and must be within the specified tolerances. Two technicians with knowledge of the assembly are required for this alignment.

6-106. The following sequence of steps should be followed to insure proper adjustment of the trestle and "A" frame.

a. Mount the platform alignment fixture onto the end of the trestle with three adjustment screws. Level the fixture by the use of the adjustment screws.

NOTE

Paint must be removed from rails to assure accuracy of platform fixture.

b. Set and level the alignment telescope on the lower shelf of the platform fixture. (See figure 6-22.)

c. Set one rail alignment fixture at the extreme front end of the rails so that the right hand rail can be aligned.

d. Set the other rail alignment fixture in the same position at the extreme far end of the rails.

e. Set an alignment (or see-throught) target into the lower right hand side of the front fixture.

f. Set a mirror (or reflection) target into the lower right hand side of the far fixture.

g. Attach a water level transversally to both rail alignment fixtures.

h. Lock two locating bars against the base plate of the alignment telescope on the lower shelf of the platform fixture. This is done to assure the accurate location of the alignment telescope.

i. Move the alignment telescope from the lower shelf of the platform fixture to the upper shelf.

j. Relocate both targets on the rail alignment fixtures from the lower right hand holes to the upper holes.

k. Maneuver the telescope on the upper platform until it is in alignment with both targets.

l. Lock two locating bars against the base plate of the alignment telescope on the upper platform of the platform fixture. This is done to assure the accurate relocation of the alignment telescope.

m. Take a reading through the alignment telescope for the entire length of the rails without loosening any bolts on the rails to determine what area on the rails needs readjustment.

n. After the area to be readjusted is determined, loosen the bolts in that specific area only.

o. Move the alignment telescope from the upper shelf of the platform fixture to the lower platform against the previously set locating bars.

p. Relocate both targets on the rail alignment fixture from the upper location to the lower right hand location.

q. Attach a water level, transversally to both rail alignment fixtures.

r. Align both targets with the alignment telescope.

s. Sight the attached water level on the rail alignment fixtures and bring the left hand rail to the same height alignment as the right hand rail.

t. Keep the rail alignment fixture at the extreme far end stationary. Move the rail alignment fixture closest to the alignment telescope toward the stationary target in steps equal to the "T" bolt spacing.

u. Securely tighten only four "T" bolts of the nine "T" bolts located in each of the three sections that make up the rail. The "T" bolts to be tightened should be the two on the extreme ends and the two at the center of each section of the rail. The remaining five "T" bolts in each section should be tightened only lightly.

v. Continue this process until a satisfactory target alignment is achieved over the entire length of the rails.

NOTE

> The "T" bolts must be locked in a perpendicular position with the rails in order to keep the distortion in the rails to a minimum.

w. Attach a light source to the alignment telescope for auto-collimating.

x. Remove the rail alignment fixture closest to the alignment telescope which has the alignment (or see-through) target.

y. Auto-collimate the right hand rail by moving the rail alignment fixture with the mirror (or reflection) target from the extreme far end of the rails toward the alignment telescope. The auto-collimation should be done over each "T" bolt as the rail alignment fixture is moved toward the alignment telescope.

z. Return the alignment telescope from the lower shelf to the upper shelf of the platform fixture. Lock the alignment telescope securely against the previously set locating bars.

aa. Return the mirror (or reflector) target from the lower right hand location to the upper location on the rail alignment fixture.

ab. Repeat procedure as in step y to auto-collimate the line of sight. Any adjustment should be done on the left hand rail.

ac. Adjust the "A" frame with the setscrews in the pads. In aligning the "A" frame do not adjust the uniballs to "swing" the line into sight. The uniballs are adjusted only to establish the correct distance between the vertical plate of the "A" frame and the trestle, and to adjust the height of the angle plate. When marking this adjustment, keep the vertical plate at 90 degrees to the line of sight.

ad. Remove the sun ring assembly prior to checking the bulkhead plates. Check the bulkhead plate at the far end first.

ae. Strap a water level on one side and on the top of the bulkhead plate. Check for squareness to the preliminary line of sight established.

af. Attach and center the sun ring centering fixture to the bulkhead plate. Center the sun ring centering fixture about the 18 inch diameter hole located in the bulkhead plate to within plus or minus .005 inch. Install the alignment (or see-through) target into the sun ring centering fixture.

ag. Simultaneously keeping the bulkhead plate level, square, and perpendicular with the top of the rails, center the alignment (or see-through) target in the sun ring centering fixture with the alignment telescope. The trial and error method will prevail in the above process. The leveling and squaring of the bulkhead plate is not as critical as the centering of the hole with the alignment telescope.

ah. Remove the sun ring centering fixture from the bulkhead plate.

ai. Mount and install the second bulkhead plate onto the "A" frame.

aj. Repeat steps ae through ah but his time using the sun ring alignment fixture for the 11-inch diameter hole in the second bulkhead plate. Both bulkhead plates must be parallel with each other after alignment.

ak. Install the sun ring assembly between the bulkhead plates into the mounting holes provided.

6-107. CAMERA CARRIAGE.

6-108. The vidicon tube has been spaced at 2.450 plus or minus .002 inches and pre-aligned so that it is level to its base mounting plate and square to its vertical mounting plate (lens mounting end). This vidicon is then mounted on a prelevel carriage assembly. Therefore, when the carriage assembly is set on the rails, the centerline of the vidicon tubes are spaced apart at the correct distance (2.450 inches). It is level to and within plus or minus .005 inch of the vertical height and within plus or minus .005 inch of the horizontal position of the desired line of sight.

6-109. Install the camera carriage onto the rails in the following manner.

a. Install the camera carriage assembly onto the rails. Do not mount the rail clamps (stand offs).

NOTE

> Make sure that the gears that engage the rail rack are unlocked so they will adjust to the rack if the carriage load is applied to them when the carriage is put on the rails.

b. Check that all rollers make contact with the rails, the V-rollers on both sides since the V-rollers maintain the alignment on the horizontal plane.

c. Re-check the rollers at two or three different places on the rail.

d. Install the lens assembly.

e. Install the lens protection ring.

f. Load the gears by had against the gear rack and lock the gears.

g. Move the carriage by hand and measure the backlash. It should not exceed plus or minus .005 inch measured at the face of the camera carriage.

h. Check the backlash over the length of the rails and adjust until minimum backlash is obtained.

i. Lock and pin the gears.

j. Install the rail clamps. They must clear the rails by plus or minus .005 inch for the total length of the rails.

k. The carriage assembly should now be mechanically aligned within plus or minus .005 inch of the desired line of sight.

l. A final check should be made by turning on the TV system only, and checking that the model is centered on the tube.

6-110. SLIDE CAMERA - (7A1A8 and 7A2A7). (See figure 6-23.)

6-111. VIDEO ALIGNMENT. Video alignment of the camera and camera control unit is basically a factory adjustment. It is not normally required when changing tubes or components in the video circuitry. When replacing a defective variable coil, set the slug adjustment of the new coil to the same point as the coil being replaced. Misalignment would be indicated by a loss in resolution in the system. Before deciding an alignment is required, the vidicon camera tube should be replaced, video tubes check by substitution, and voltage measurements made.

6-112. Vidicon Camera Tube Alignment. Proper alignment is required to insure good overall focus and shading of the vidicon presentation. The following alignment procedure is normally done when replacing the vidicon camera tube.

a. Rock the FOCUS control on the remote control panel slowly both clockwise and counterclockwise. The picture should rotate around some fixed point on the picture. Proper alignment exists when the rotation center is at the center of the picture.

b. Using a finger, slowly rotate one of the two circular alignment magnets while the FOCUS control on the remote control panel is being varied.

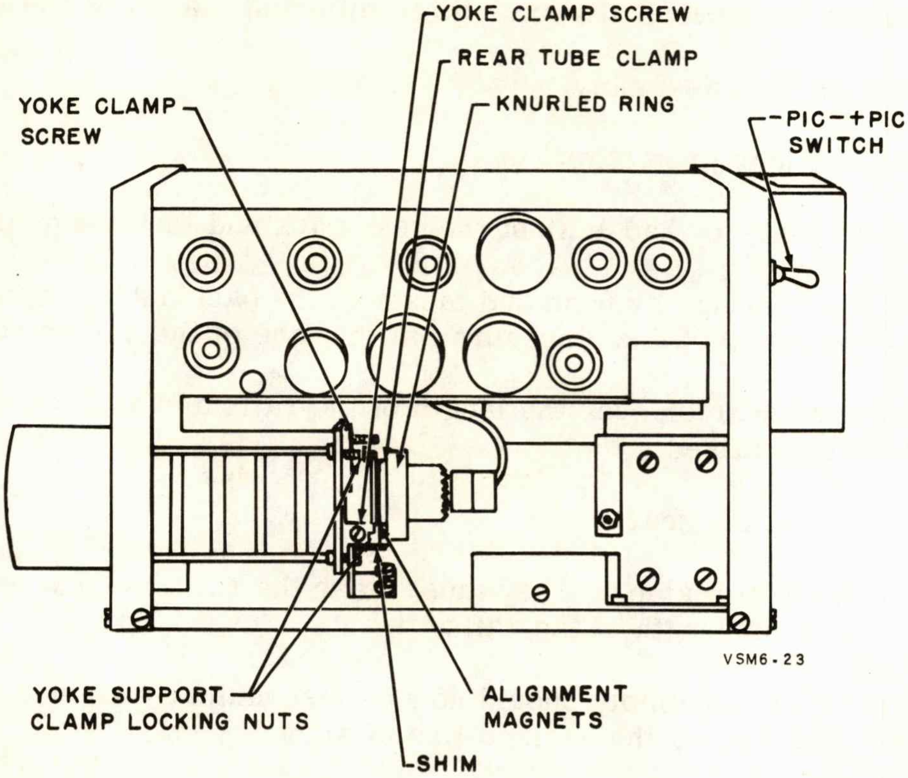


Figure 6-23. Slide Camera Components

c. When the magnet reaches a position which gives the best alignment, stop turning this magnet and turn the section magnet for improved indication.

NOTE

It may be necessary to repeat steps a and b several times until the picture rotates around a central point. A slight movement of circular magnet at his point can materally aid shading without affecting alignment.

6-113. Yoke of Vidicon Tube Adjustment. For initial yoke adjustment, proceed as follows:

a. Carefully focus the vidicon camera tube using the focus control on the remote control panel.

b. Loosen the two yoke support clamp locking nuts and lock the support clamp of the yoke to the focus coil assembly.

c. Loosen the knurled ring.

d. Rotate the support clamp to correct the presentation on viewer.

e. Lock the two yoke support clamp locking nuts.

f. Tighten the knurled ring by hand.

6-114. When the previous adjustment does not permit sufficient rotation of the deflection yoke, proceed as follows for a major yoke adjustment.

NOTE

> If this procedure is not done properly, the front of the deflection yoke will not be sufficiently grounded, there by ausing vertical bars to affect the vidicon presentation.

a. Place tape over the exposed vidicon pins to prevent the ring from short circuiting the pins. Remove the knurled ring.

b. Loosen two yoke support clamp locking nuts, locking the yoke clamp in two places.

c. Place the shims approximately .025 inches thick, under the clamp in two places.

d. Tighten the yoke support clamp locking nuts. Be certain the slotted hole is centered on the studs.

e. Loosen the two yoke clamp screws on the yoke clamp.

f. Rotate the rear tube clamp for proper orientation of the vidicon presentation.

g. Press the rear tube clamp forward to insure the front of the yoke is properly grounded; then tighten the two yoke clamp screws.

h. Remove the shims and tighten the yoke support clamp locking nuts.

i. Replace the knurled ring and tighten.

6-115. VIDICON ADJUSTMENT. Since the vidicon is an extremely sensitive tube, certain precautions must be taken to insure optimum performance.

a. Adjust the camera scanning to utilize maximum useful area of photoconductive layer. Do not underscan the photoconductive layer. This will result in raster burn.

b. Match any visible raster pattern on photoconductive layer with new scan.

c. Align the electron beam.

d. With the lens capped, adjust the signal electrode voltage for each individual vidicon to the highest value that will still give uniform background. Do not increase the signal-electrode voltage above this value in trying to obtain a "snappy" picture. This will result in excessive white flare.

e. Open the lens iris or increase the scene illumination to obtain the "snappiest" picture without noticable smear from moving objects.

f. Use only a sufficient beam current to bring out the picture highlights.

g. Do not change the camera size and centering controls once the scanned area of photoconductive layer has been properly positioned, or a displace raster may result.

h. Do not rotate the vidicon from its original operating position in the deflecting yoke or raster burn may result.

i. Do not turn on beam of vidicon without normal scanning.

6-116. ALIGNMENT OF SLIDE PROJECTOR WITH GPL TELEVISION CAMERA.

6-117. Instruction for alignment of the camera with the projector are as follows:

a. Remove the camer-slide projector frame from cabinet.

b. Turn the "on-off" switch on the camera control panel to the "ON" position. Wait for the red light in the associated 300-volt power supply to illuminate.

c. Turn the vertical and horizontal size adjustments completely counterclockwise.

d. Adjust the target, beam, pedestal, and video gain so that the circular edge of the vidicon is visible upon the monitor.

e. Adjust the vertical center and horizontal center screwdriver adjustments until the circle is centered upon the camera.

f. Insert a test pattern slide into the slide projector and adjust the projector lens to "f/8".

g. Turn the projector "on-off" switch at the back of the projector to the "ON" position.

h. Adjust the target, beam, focus, pedestal, and gain for the best picture quality, and for 0.7 volts peak-to-peak output on the waveform monitor (Tektronix - RM 527).

i. Adjust the slide projector position so that the test pattern just fits inside the circular edge of the vidicon with proper optical focus. Movement of the vidicon may be necessary to locate the optimum position.

j. Adjust the horizontal and vertical size screwdriver adjustments to expand the pattern size to the edge of the raster. Slight adjustments of horizontal and vertical centering may be necessary.

k. Readjust the target, beam, focus, pedestal, and video gain for optimum resolution.

l. Turn the camera control panel on-off switch to the "OFF" position.

m. Install the projector assembly in cabinet.

n. Turn camera control panel on-off switch to the "ON" position.

o. Adjust the target, beam, focus, pedestal, and video gain for optimum resolution and for 0.7 volts peak-to-peak output as viewed on the waveform monitor and picture monitor.

6-118. WAVEFORM MONITOR.

6-119. Calibration with internal reference should be checked before each measurement as follows.

a. To calibrate volts/horizontal lines, turn CALIBRATOR from external to either ".714" or "1.0".

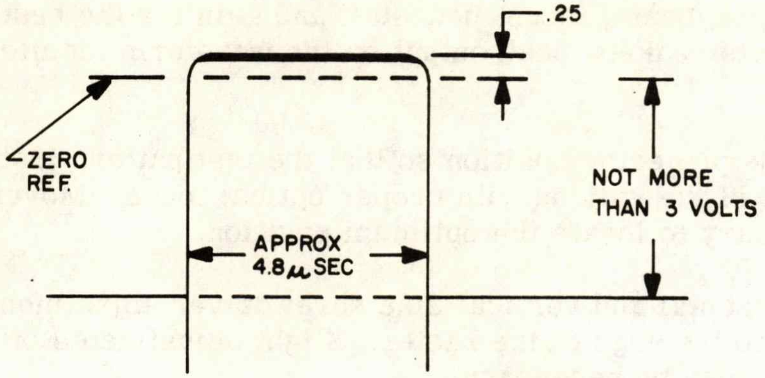
b. Turn INPUT to "CAL" position.

c. Adjust GAIN to desired level. (Ex. 5 lines/volt).

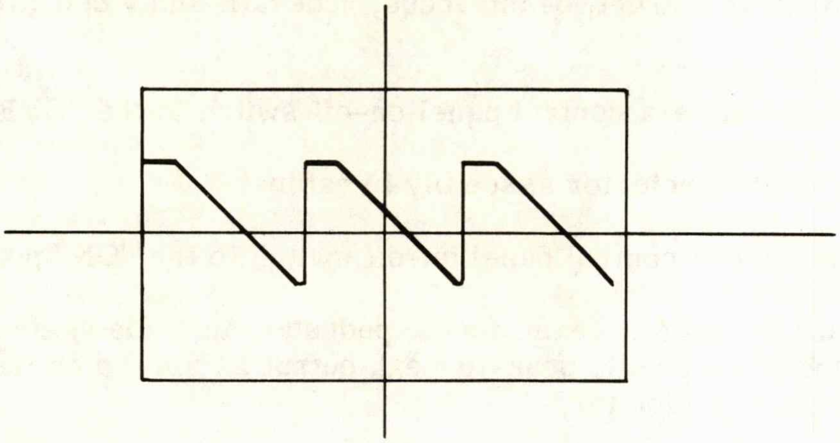
d. Switch INPUT to "A".

e. Switch CALIBRATE to "EXT".

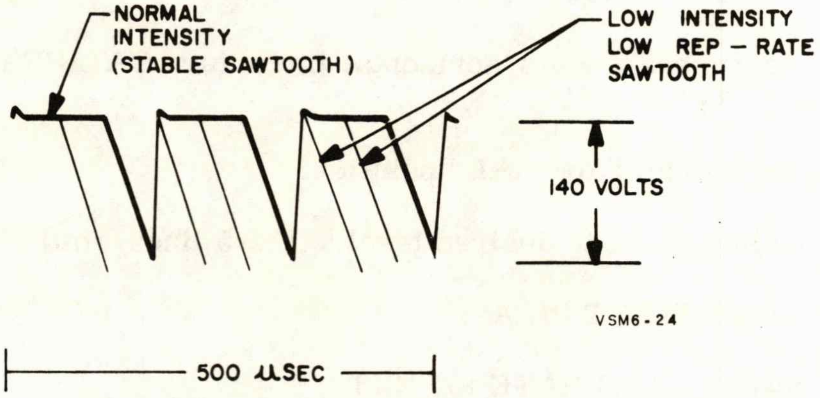
6-120. WAVEFORM MONITOR INTERNAL CALIBRATION. (See figure 6-24.) The steps in this procedure are arranged in a sequence to avoid unnecessary repetition. The procedure should be performed after each 500 hours of operation. Test equipment used in a particular step should be left connected at the end of that step, unless the instructions state otherwise. Similarly, controls not mentioned are assumed to be in the positions they were in at the conclusion of the preceding step.



TRIGGER MULTIVIBRATOR BIAS



SWEEP GATING MULTIVIBRATOR BIAS
WAVEFORM * 1



SWEEP GATING MULTIVIBRATOR BIAS
WAVEFORM * 2

Figure 6-24. Waveform Monitor Adjustment Presentations

6-121. The following equipment is required to perform a complete calibration of this instrument.

a. 1X "straight through" probe; no attenuation. A 24 to 36 inch length of coaxial cable, with a UHF connector on one end, may be used in lieu of the probe.

b. Probe (bandpass, dc to 10 mc; attenuation, 10x; input capacitance, approximately 14 pf.).

c. 75 ohm 10 to 1 "T" attenuator.

d. 75 ohm terminating resistor.

6-122. Preliminary Adjustments. Connect the type 527 to the autotransformer output. Use the a-c voltmeter (item 19, table 6-1) to monitor the output voltage of the autotransformer. Turn on the type 527 and the test oscilloscope (item 21, table 6-1). Adjust the autotransformer (item 25, table 6-1) to the design-center voltage for which the instrument is wired and allow at least five minutes warn-up before making any adjustments. Preset the type 527 front panel controls as follows:

CALIBRATOR	".714"
INPUT	"A"
RESPONSE	"IRE"
GAIN	Switch to "HIGH" and rotate GAIN control fully counterclockwise.
MAGNIFIER	"X1"
DISPLAY	"2 LINE"
EXT-INT SYNC.	"INT"

6-123. Low-Voltage Power Supplies. Measure the output of the minus 140-, plus 140-, and plus 280-volt supplies with a d-c voltmeter (item 19, table 6-1).

a. The plus 140-volt and plus 280-volt supplies depend on the minus 140-volt supply. If the minus 140-volt supply is out of tolerance, adjust the minus 140-volt adjustment (R636) for a reading of exactly minus 140 volts. Take this reading at junction of pin V619 and R622.

b. Check the plus 140-volt supply at pin 3 of V657. Be sure this is within a three percent tolerance.

c. Check the plus 280-volt supply at the junction of pin 2, V677 and R670. A three percent tolerance is allowable.

6-124. Regulation of Low-Voltage Supplies. To check the power supplies for regulation, vary the autotransformer voltage between 105 volts and 125 volts.

All the supply voltages should remain constant. Once this is accomplished, disconnect the d-c voltmeter.

6-125. Ripple in Low-Voltage Supply. Check the ripple in the low voltage supply as follows:

a. Set the test oscilloscope vertical deflection factor to 0.05 volts/cm, a-c coupled, and the sweep rate to 10 millisec/cm.

b. Set the trigger controls to free run the sweep.

c. Connect a 1X or "straight through" probe from the test oscilloscope to the minus 140-, and plus 280-volt test points (see paragraph 6-105 A, B, C) and measure the ripple amplitude at low line and high line at each of the test points. The ripple amplitude should measure less than 20 millivolts at nominal line on each of the supplies; at low and high line the ripple amplitude should be less than 30 millivolts. Disconnect the 1X probe from the type 527 and from the test oscilloscppe. Set the autotransformer to the design-center voltage.

6-126. High-Voltage Power Supply. Check the high-voltage power supply as follows:

a. Connect the VOM (item 24, table 6-1) between ground and the junction of B847 and R847.

b. Adjust the -3800 volt control for -3800 volt reading. Vary the autotransformer (item 25, table 6-1) between low and high line; the high should remain essentially constant over the range.

c. Reset the autotransformer to the design-center voltage.

d. Disconnect the voltmeter.

6-127. Trigger Multivibrator Bias. Check the trigger multivibrator as follows:

a. Connect a video signal (item 16, table 6-1) of one of the video input A connectors.

b. Connect a short jumper lead from the other video input A connector to one of the video input B connectors.

c. Set the INPUT SELECTOR switch to "A" and the DISPLAY switch to "2 FIELD".

d. Set the test oscilloscope (item 21, table 6-1) vertical reflection factor to 1 volt/cm, d-c coupled, and the sweep rate to 10 microsec./cm.

e. Set the TRIGGER controls to "+ INTERNAL".

f. Connect the cable end of the 10X probe to the oscilloscope vertical input connector.

g. Free run the sweep, ground the probe tip, and position the trace two centimeters above the graticule centerline to establish a zero voltage reference line.

h. Connect the 10X probe tip to the junction of R29 and R31.

i. Adjust the oscilloscope controls for triggered sweep. Note that the video signal is inverted, and the horizontal sync pulse tip is approximately 0.25 volt above ground or zero reference.

j. Horizontally position the center of the sync pulse to the center of the graticule and set the oscilloscope magnifier switch to the X5 position.

k. Adjust the TRIG. MULTI. BIAS adjustment to obtain the display in figure 6-24.

6-128. Sweep Gating Multivibrator Bias. Check the sweep gating multivibrator bias as follows:

a. Set the oscilloscope (item 21, table 6-1) vertical deflection factor to 50 volts/cm, d-c coupled, the magnifier switch to "OFF" or "NORMAL", and the SWEEP RATE to "5 MILLISEC/CM".

b. Connect the 10X probe to pin 8, V161.

c. Set the type 527 DISPLAY switch to the "RGB FIELD" position.

d. For a preliminary setting of the SWP, GATING MULTI. BIAS adjustment (R176), rotate the control fully clockwise. Then rotate the control slowly counterclockwise until a sawtooth waveform is displayed on the test oscilloscope (see figure 6-24). Then rotate the control about five degrees further counterclockwise.

e. Check for a sawtooth waveform when the DISPLAY switch is set to the "2 FIELD" and "VIT." positions. While the DISPLAY switch is set to the "VIT." position, set the INPUT switch to "CAL" and check for a sawtooth on the oscilloscope.

f. Set the INPUT switch to the "A" position.

g. Set the oscilloscope for a sweep rate of 50 microsec/cm.

h. Check for a sawtooth on the oscilloscope when the type 527 DISPLAY switch is in the "RGB LINE", "2 LINE", and ".125 H/CM" positions of the DISPLAY switch. Overlook the low repetition rate (low intensity) sawtooth waveforms that appear when the type 527 triggers on the equalizing pulses, as shown in figure 6-24.

i. If a stable display is obtained, the SWP. GATING MULTI. BIAS control needs no further adjusting. If the sweep stops or free runs when checking for sawtooth waveform, readjust the SWP GATING MULTI BIAS control to obtain a stable display approximately in the middle of the control's stable range. If the control is readjusted, recheck all positions of the DISPLAY switch to be sure that a sawtooth is displayed on the oscilloscope.

j. Disconnect the 10X probe.

6-129. Horizontal Gain. Set the DISPLAY switch to the "2 FIELD" position. Adjust the HORIZ. GAIN control (R375) for a sweep length of 10 centimeters on the type 527 screen. Use the POSITION controls to position the back-porch level of the sync pulses at 0 IRE. on the graticule so that the sweep length can be easily determined.

6-130. Astigmatism. Set the DISPLAY switch to the "2 LINE" position and the INPUT selector switch to "CAL". Set the VERTICAL POSITION control to midrange. Adjust the ASTIG. control (R864) in conjunction with the FOCUS control to obtain focus of the trace at the lower corners of the calibrator pulses.

6-131. Preliminary Setting of C160C. Set the INPUT selector switch to the "A" position. Adjust C160C for a stable display in the "2 LINE" and both "RGB" positions of the DISPLAY switch.

6-132. Horizontal Sweep Linearity. Rotate the DISPLAY switch between "2 LINE" and "2 FIELD", and adjust C320 for the same sweep starting point in both positions of the switch.

6-133. Final Setting of C160C. Adjust C160C so that the second line horizontal sync pulse is centered on the second vertical sync pulse when the DISPLAY switch is moved from "2 LINE" to the "2 FIELD" position.

6-134. 0.125 H/CM Sweep Rate. Set the DISPLAY switch to ".125 H/CM" and RESPONSE switch to "FLAT". Adjust C160C so that identical points on the line sync pulses are 8 centimeters apart.

6-135. X5 Magnifier. To check the X5 magnifier, accomplish the following:

a. Set the MAGNIFIER switch to the "X5" position and adjust the intensity.

b. Position the display to the right with the HORIZONTAL POSITION control so that the sweep starts at the left side of the graticule.

c. While switching between the "2 LINE" and "2 FIELD" positions, adjust C334 so that the sweep starts at the same point.

6-136. X25 Magnifier. Follow a procedure similar to the X5 magnifier to check for operation of the X25 magnifier.

6-137. Sweep Magnifier Registration. Check the sweep magnifier registration by accomplishing the following:

a. Set the DISPLAY switch to "2 FIELD".

b. Horizontally position the trace so that the sweep starts at the center of the graticule.

c. Set the MAGNIFIER switch to "X1".

d. Adjust the INTENSITY control for normal trace brightness, and adjust the SWP./MAG. REGIS control (R355) so that the sweep starts at the center of the graticule.

6-138. Calibrator Amplitude. Check the calibrator amplitude as follows:

a. Set the INPUT selector switch to "CAL", the CALIBRATOR to "1.0" and the DISPLAY switch to "2 LINE".

b. Turn off the instrument and remove V800 to disable the high voltage oscillator.

c. Turn the instrument back on, set the precision d-c voltmeter (item 24, table 6-1) for 1,000 volt. Connect the voltmeter to the junction of R882 and R884, and adjust the CAL AMP. control (R886) for null reading on the meter.

NOTE

> The operation of the calibrator is such that when the voltmeter method is used, the calibrator voltage will tend to be low. Therefore, the voltmeter reading should actually be 1 to 3 millivolts higher than the 1 volt setting previously given. The CAL AMPL control should never be set for a meter reading of less than one volt.

d. Turn the instrument off, disconnect the voltmeter, return V800, and turn on the power. Reinstall the CALIBRATOR knob.

6-139. Input Attenuator Compensation. The input attenuator compensation should be checked using the following step by step procedures.

a. Set the DISPLAY switch to "2 LINE" and the GAIN control to the "LOW".

b. Use the HORIZONTAL POSITION control to position the display to start at the left side of the graticule.

c. Use the VERTICAL POSITION control to position the bottom of the calibrator pulses to the 0 IRE graticle line.

d. Adjust the GAIN control so the calibrator pulses are approximately 80 IRE units in amplitude.

e. Adjust C406 for a flat-topped calibrator waveform, on the type 527 screen.

6-140. A-B Differential. With the video signal applied to the video input A and B connectors, set the INPUT selector switch to "A-B" and rotate the GAIN control fully clockwise with the GAIN switch remaining in the "LOW" position. Adjust C506 for best signal rejection.

6-141. CRT Beam Rotator. Adjust R860 so that the horizontal trace aligns with the 0 IRE graticule line.

6-142. D-C Balance. Adjust the d-c balance as follows:

a. With the trace aligned with the 0 IRE graticule line, adjust the DC BAL. control (R432) for minimum trace movement while rotating the gain control through its low range.

b. Disconnect the video signal from the A and B connectors.

6-143. External Negative Sync Input Compensation. External nagative sync input compensation is checked as follows:

a. Apply a one-volt calibrator signal from the test oscilloscope (item 21, table 6-1) to the Ext. Neg. Sync. Input connector.

b. Set the INT.-EXT. SYNC switch to "EXT." and remove V35 from the socket.

c. Set the oscilloscope vertical deflection to 10 volts/cm and sweep rate to 0.5 millisec/cm. Connect the 10X probe to pin 5 of V24 and adjust the oscilloscope triggering controls for a stable display.

d. Adjust C1 for best square corner at the top of the waveform. Disconnect the probe and return V35 to its socket.

6-144. Vertical Compression and Expansion. Check vertical compression and expansion using the following method:

a. Set the oscilloscope (item 21, table 6-1) calibrator for a 50 millivolt output.

b. Disconnect the calibrator signal from the Ext. Neg. Sync. Input connector and connect it to the Video Input B connector.

c. Set the INT.-EXT. SYNC. switch to "INT".

d. Set the INPUT selector switch to "B" and the DISPLAY switch to "2 FIELD".

e. Set the GAIN control to "HIGH" and rotate the control until the waveform is 10 IRE units in amplitude.

f. Position the waveform first to the top of the graticule and then to the bottom.

g. The amplitude of the waveform should not change more than one trace width, or 0.14 IRE unit, as the waveform is positioned vertically within the graticule limits.

6-145. Vertical Amplifier Sensitivity. Use the following methods to check vertical amplifier sensitivity.

a. Rotate the GAIN control fully clockwise and check the amplitude of the waveform; it should be at least 20 IRE units.

b. Set the GAIN control to "LOW" and rotate the GAIN control fully counterclockwise.

c. Increase the test oscilloscope (item 21, table 6-1) calibrator signal to 500 millivolts. The amplitude of the waveform displayed on the type 527 should be 30 IRE units or less.

d. Disconnect the test oscilloscope calibrator signal.

6-146. High-Frequency Compensations. Adjust the high-frequency compensation using the following method.

a. Connect a test lead from the test oscilloscope (item 21, table 6-1) +Gate Output connector to the INT.-EXT. SYNC. switch.

b. Connect the 10X probe to the center tap on L500 to trigger the test oscilloscope.

c. Set the oscilloscope vertical reflection factor to 0.5 volts/cm and the sweep rate to 20 microsec/cm.

d. Apply a 5-mc, 10-volt signal from the constant amplitude signal generator (item 15, table 6-1) through a 10 to 1 "T" Attenuator to the Video Input B connector. Terminate the other B connector with a 75-ohm termination.

e. Check to see that the **RESPONSE** switch is set to "**FLAT**".

f. Set the **DISPLAY** switch to "**2 LINED**.

g. Adjust the test oscilloscope for triggered-sweep operation.

h. Adjust the type 527 GAIN control for approximately 80 IRE units vertical deflection.

i. Adjust L421 and L521, in equal increments for maximum signal amplitude on the type 527 screen.

j. Adjust L442 and L542, in equal increments for maximum signal amplitude. Set the generator frequency to 50 kc and adjust the oscilloscope controls if necessary, to obtain a stable display.

k. Adjust the type 527 GAIN control for an amplitude of 100 IRE units.

i. Increase the generator frequency to 5 mc.

m. Adjust L462 and L562 to obtain 100 IRE units amplitude of displayed signal.

6-147. Bandpass. Adjust the bandpass by the following method.

a. Set the signal generator (item 15, table 6-1) for a frequency of 50 kc, and check display screen of type 527 for 100 IRE units in amplitude.

b. Set generator frequency to 350 kc. The amplitude should remain 100 IRE units.

c. Increase the generator frequency to 5 mc. The amplitude should not change more than one percent out of 5 mc.

d. Increase the generator frequency to 9 mc. The amplitude should be at least 70.7 IRE units.

e. Decrease the generator to 350 kc and set the RESPONSE switch to "IRE". The amplitude of the display should be at least 98 units.

f. Set the generator frequency to 3.58 mc. The amplitude should not be more than 10 IRE units (20 db down).

6-148. TELEVISION MONITOR.

6-149. Adjustment of the television monitor is accomplished as follows:

a. Connect the output of the dot generator (item 16, table 6-1) to the input of the television monitor located on the back of the monitor (J3).

b. Change the INPUT Z switch to the "HIGH" position mounted on the back of the monitor.

c. Change the SYNC switch to the "EXTERNAL" position.

d. Place the D.C. RES. switch to the "IN" position.

e. Adjust the "horiz. lin." screwdriver control for maximum picture width, then turn adjustment counterclockwise one-half to two turns for best linearity.

f. Adjust the "width" screwdriver control for desired width.

g. Adjust the "h. hold", "v hold", "contrast" and "brightness" until desired pattern appears.

h. Adjust the "focus" control located on the front panel while watching the picture for maximum detail.

i. Reduce the "horizontal drive" located on the front panel by turning the control counterclockwise until the picture becomes quite narrow and somewhat dim. Set the horizontal hold for normal synchronization. Increase the drive by turning the drive control clockwise until either the picture falls out of synchronization or a "driver bar" (bright vertical bar near the center of the screen) appears. In either case, reduce the drive until the condition disappears.

6-150. HIGH RESOLUTION TELEVISION SYSTEM.

6-151. Initial adjustment of the high resolution television system is accomplished as follows:

a. Before applying power to the system, all cabling should be checked and care taken to determine that all correct terminations are properly in place.

b. Turn the sync generator "on" and observe all pulses at the test points on the front panel. Check to ascertain that they are of proper amplitude, duration, and frequency. S2 (AFC-EXT - XTAL) will normally be in the AFC - SLOW, or AFC - FAST positions unless syncronization with another unit is intended.

c. Turn the monitor "on", and allow sufficient time for warm up.

d. Adjust the monitor for a suitable raster.

e. Rotate the BEAM and TARGET controls on the camera control front panel all the way counterclockwise and switch the NORMAL-OVERSCAN switch to the "OVERSCAN" position before applying power to the camera and camera control unit.

6-152. Adjustment of the CRT for the best picture may be accomplished by use of the waveform monitor (7A2A3). By analyzing the video waveforms and adjusting the remote control unit, the desired video reception may be realized. Adjustment may be accomplished through use of the following procedure:

a. After power has been supplied to the cabinet, calibrate the oscilloscope (item 21, table 6-1) for the desired sensitivity.

b. Adjust the gain for the desired level.

c. By reference to the oscilloscope, adjust the black level (minimum pattern above the blanking level) to 10 percent of the total video signal above the blanking level.

d. Set the "Line Selector" on the oscilloscope approximately five rotations from its full clockwise position. This selects a line approximately in the middle of the raster.

e. Place the DISPLAY switch in either the "LINE SELECT" or "2 LINE" position.

f. Adjust the FOCUS control on the remote control panel for maximum modulation (amplitude of the video signal).

g. Set the TARGET voltage control on the remote control panel to approximately one-eighth of a turn from its full counterclockwise position.

h. Turn the BEAM control on the remote control panel from its full counterclockwise position until maximum resolutuion is noted. This would be seen as a peak in amplitude on the waveform monitor. Do not turn control beyond this point or loss of resolution will result.

6-153. BEACON GENERATOR.

6-154. The calibration of the beacon generator is composed of three areas; beacon size, beacon position and beacon intensity. The adjustment is as follows:

a. Beacon Size. The vertical beacon size is adjusted by tuning the 200 microsecond delay to approximatley a 6 raster line height.(approximately 185 microseconds). Adjust the horizontal beacon size by tuning the 1.5 microsecond delay to approximately 1.5 microseconds.

b. Beacon Position. Vertical beacon position is adjusted by applying a feedback signal within the counter-string to provide a count of less than 256 lines to a minimum of 245 lines (245 - 256 line range). Adjust the horizontal beacon position by tuning the 15 microsecond multivibrator to bring the beacon signal to the center of the raster. (Approximately 18 microseconds.)

c. Beacon Intensity. The beacon intensity is adjusted by means of a potentiometer on the output amplifier. Adjustment should be made for an output pulse of 0.7 volts peak. Each window must be adjusted individually.

6-155. MODEL SERVO SYSTEM. The model servo system is composed of 13 servos, 4 of which are 360 degree continuous rotation servos and 9 are limited rotation servo. Calibration of these servos does not require special tools except for one test fixture which is needed to insure proper operation in the "auto" mode. The schematic diagram for this "computer simulator" may be seen on figure 6-25.

CAUTION

> Be sure that in all testing the test probes do not short circuit outputs to ground. Extreme caution should be observed at all times.

6-156. ETA Model Servo. Adjustment of the Eta servo is accomplished using the following procedure:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Remove the three fuses from card 6A2A2A6 (power amplifier).

d. Install card 6A2A2A2 (summing card).

e. Install card 6A2A2A1 (preamplifier in automatic mode, no manual function).

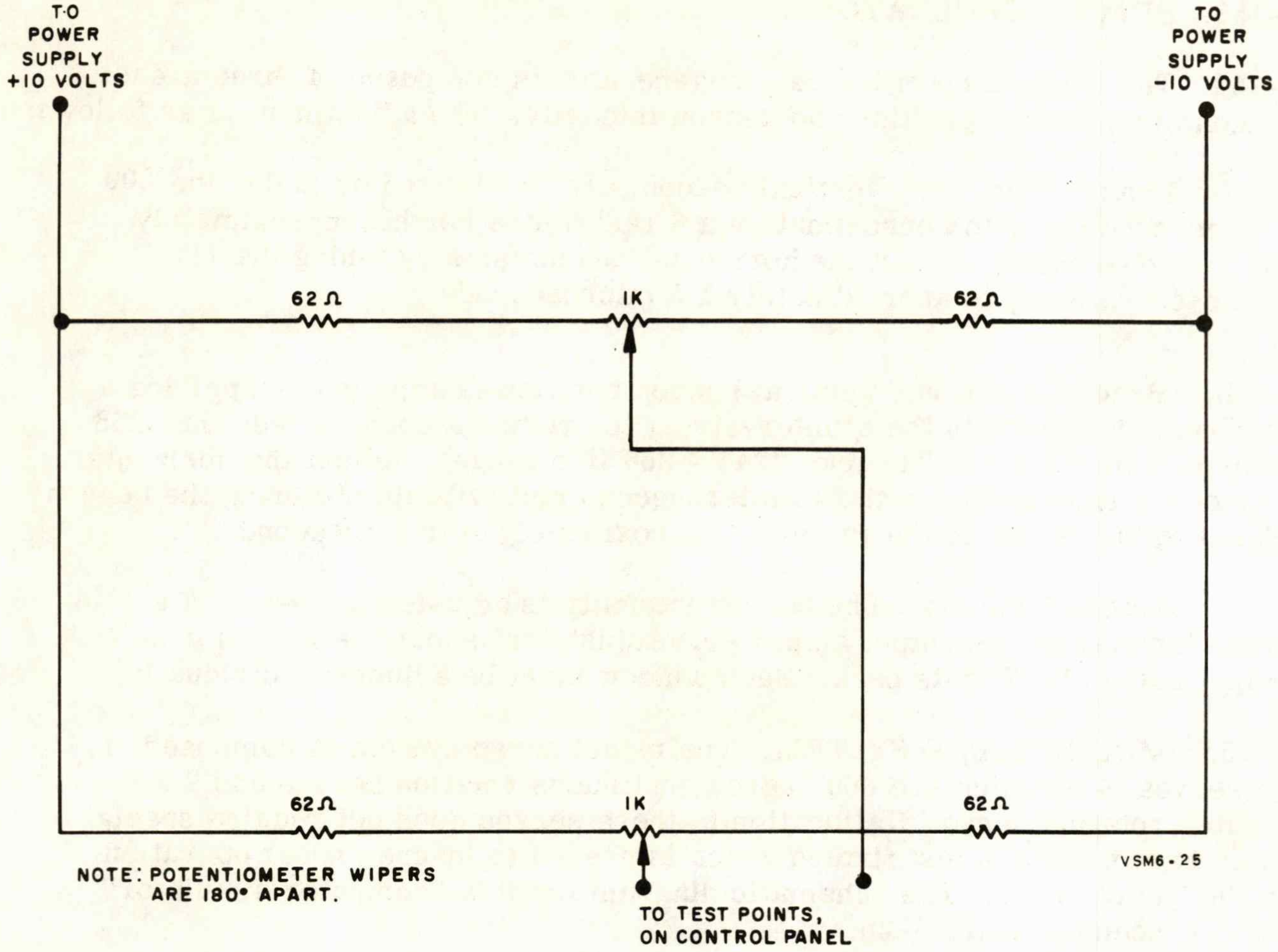


Figure 6-25. Servo Test Fixture Schematic

f. Install card 6A2A2A3 (preamplifier in automatic mode, no manual function).

g. Install card 6A2A2A4 (buffer inverter in automatic mode, preamplifier in manual mode).

h. Install card 6A2A2A5 (driver, both modes).

i. Install card 6A2A2A6 (power amplifier, both modes).

j. Turn all switches to "ZERO TEST" on summing card 6A2A2A2.

k. Connect the ground of a millivac or VTVM (item 19, table 6-1) to signal ground (TP27 on the control panel) and use the remaining probe to check any of the test points except 6A2A2A6TP1.

l. Adjust each of the amplifiers to as near a zero reading as possible.

NOTE

The drive amplifier will not approach zero. This is because the gain is not 1:1 as are all the other Donner stages and is more subject to noise. A reading of 25 mv is a satisfactory reading for this stage.

The 1:1 stages closely approach zero voltage when properly adjusted. The zeroing potentiometer is visible from the handle of each card. Adjust each potentiometer slowly and pause periodically to give the amplifier a chance to settle.

m. Turn the auto-manual switch on the control panel to the "MANUAL" position.

n. Connect the test probes of an oscilloscope (item 21, table 6-1) between TP27 (gnd.) and TP15 on the control panel.

o. When the "- to +" potentiometer on the control panel is turned from one extreme to the other, a voltage swing of approximately plus 8.0 volts to minus 8.0 volts should be noted. Due to the trim resistors on the potentiometers which limits voltage a full plus or minus 10 volts dc will not be realized.

p. Return the test switches on summing card 6A2A2A2 back to the "OPERATE" position.

q. With the fuses still removed from power 6A2A2A6, move the test probe to TP1 on summing card 6A2A2A2.

r. Move the "- to +" potentiometer on the control panel to its extremes. A voltage swing from plus 5 volts to minus 5 volts should be noted. If the tolerance extremes are 0.25 volts or more, replace 6A2A2A2CR5.

s. Move the test probe to power amplifier card 6A2A2A6 test point TP2. This is essentially the output of driver 6A2A2A5. With the " - to +" potentiometer manually adjusted to the extremes, a voltage of plus or minus 30 volts dc should be noted. It should also be noted that this voltage is inverted with respect the preamplifier 6A2A2A4 (180 degree inversion thru amplifier).

t. Install the fuses in power amplifier 6A2A2A6, and check the gain of the stage. The servo should now respond to commands.

u. Remove summing card 6A2A2A2 and adjust R3 (feedback setting) to read 5.5k ohms between pins 1 and 2.

v. Set R24 (gain) for a reading of 1.4k ohms between pins 1 and 2. The servo is now ready for test operation.

w. Remove cable W101A6-J1 and switch the "auto-manual" switch to "AUTO".

NOTE

Cable must be removed to insure that the computer signals are not being superimposed upon the test signal.

x. By use of the test fixture (see figure 6-25), computer simulated signals may be injected into the monitoring points TP16 and TP17 on the control pnael. It should now be possible to continuously rotate the servo under test. A voltage swing of plus or minus 5 volts dc should be noted at 6A2A2A2 TP2.

NOTE

The test fixture is connected acorss the plus or minus 10-volt power supply and the probes are connected to the wipers of the 1K "ganged" potentiometers connected to the monitoring points for computer simulation.

y. Move the probe on the oscilloscope to 6A2A2A6TP2 and check for a voltage swing of approximately plus or minus 30 volts.

z. The adjustment of the Eta servo is now complete.

6-157. ZETA Model Servo. Adjustment of the Zeta servo is accomplished using the following procedure:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Remove the 3 fuses from card 6A2A2A7 (power amplifier).

d. Install card 6A2A2A7 (power amplifier).

e. Install card 6A2A2A8 (Driver, automatic or manual).

f. Install card 6A2A2A9 (preamplifier on manual, buffer on automatic).

g. Install card 6A2A2A10 (preamplifier on automatic, no manual function).

h. Install card 6A2A2A11 (summing card).

i. Install card 6A2A2A12 (preamplifier on automatic, no manual function).

j. Turn all switches to "ZERO TEST" on summing card 6A2A2A11.

k. Connect the ground of a millivac or VTVM (item 19, table 6-1) to signal ground (TP27 on the control panel) and use the remaining probe to check any of the test points except 6A2A2A7TP1.

l. Adjust each of the amplifiers to as near a zero reading as possible.

NOTE

The drive amplifier will not approach zero. This is because the gain is not 1:1 as are all the other Donner stages and is more subject to noise. A reading of 25 mv is a satisfactory reading for this stage.

The 1:1 stages closely approach zero voltage when properly adjusted. The zeroing potentiomenter is visible from the handle of each card. Adjust each potentiometer slowly and pause periodically to give the amplifier a chance to settle.

m. Turn the "auto-manual" switch on the control panel to the "MANUAL" position.

n. Connect the test probes of an osiclloscope between TP27 (gnd.) and TP12 on the control panel.

o. When the "- to +" potentiometer on the control panel is turned from one extreme to the other, a voltage swing of approximately plus 8.0 volts to minus 8,0 volts should be noted. Due to the trim resistors on the potentiometers which limits voltage, a full plus or minus 10 volts dc will not be realized.

p. Return the test switches on summing card 6A2A2A11 back to the "OPERATE" position.

q. With the fuses still removed from power amplifier 6A2A2A7 move the test probe to TP1 on summing card 6A2A2A11.

r. Move the "- to +" potentiometer on the control panel to its extremes. A voltage swing from plus 5 volts to minus 5 volts should be noted. If the tolerance extremes are 0.25 volts or more, replace 6A2A2A11CR5.

s. Move the test probe to power amplifier card 6A2A2A7 test point TP2. This is essentially the output of driver 6A2A2A8. With the "- to +" potentiometer manually adjusted to the extremes, a voltage of plus or minus 30 volts

dc should be noted. It should also be noted that this voltage is inverted with respect to preamplifier 6A2A2A9 (180 degree inversion thru amplifier).

t. Install the fuses in power amplifier 6A2A2A11 and check the gain of the stage. The servo should now respond to commands.

u. Remove summing card 6A2A2A11 and adjust R3 (feedback setting) to read 400 ohms between pins 1 and 2.

v. Set R24 (gain) for a reading of 7.5k ohms between pins 1 and 2. The servo is now ready for test operation.

w. Remove cable W101A6-J1 and switch the "auto-manual" switch to "AUTO".

NOTE

Cable must be removed to insure the computer signals are not being superimposed upon the test signal.

x. By use of the test fixture (see figure 6-25), computer simulated signals may be injected into the monitoring points TP13 and TP14 on the control panel. It should now be possible to continuously rotate the servo under test. A voltage swing of plus or minus 5 volts dc should be noted at 6A2A11 TP2.

NOTE

The test fixture is connected across the plus or minus 10-volt power supply and the probes are connected to the wipers of the 1k "ganged" potentiometers connected to the monitoring points for computer simulation.

y. Move the probe on the oscilloscope to 6A2A2A7TP1 and check for a voltage swing of approximately plus or minus 30 volts.

z. The adjustment of the Zeta servo is now complete.

6-158. XI Model Servo. Adjustment of the XI servo is accomplished by the following procedure.

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Remove the three fuses from card 6A2A3A6. (power amplifier)

d. Install card 6A2A3A2 (summing card).

e. Install card 6A2A3A1 (preamplifier in automatic mode, no manual function).

f. Install card 6A2A3A3 (preamplifier in automatic mode, no manual function).

g. Install card 6A2A3A4 (buffer inverter on automatic, preamplifier on manual).

h. Install card 6A2A3A5 (drivers in both modes).

i. Install card 6A2A3A6 (power amplifier in both modes).

j. Turn all switches to "ZERO TEST" on summing card 6A2A3A2.

k. Connect the ground of a millivac or VTVM (item 19, table 6-1) to signal ground (TP27 on the control panel) and use the remaining probe to check any of the test points except 6A2A3A6TP2.

l. Adjust each of the amplifier to as near a zero reading as possible.

NOTE

> The drive amplifier will not approach zero. This is because the gain is not 1:1 as are all the other Donner stages and is more subject to noise. A reading of 25 mv is a satisfactory reading for this stage.

The 1:1 stages closely approach zero voltage when properly adjusted. The zeroing potentiometer is visible from the handle of each card. Adjust each potentiometer slowly and pause periodically to give the amplifier a chance to settle.

m. Turn the "auto-manual" switch on the control panel to the "MANUAL" position.

n. Connect the test probes of an oscilloscope (item 21, table 6-1) between TP27 (gnd.) and TP9 on the control panel.

o. When the "- to +" potentiometer on the control panel is turned from one extreme to the other, a voltage swing of approximately plus 8.0 volts to minus 8.0 volts should be noted. Due to the trim resistors on the potentiometers which limits voltage, a full plus or minus 10 volts dc will not be realized.

p. Return the test switches on summing card 6A2A3A2 back to the "OPERATE" position.

q. With the fuses still removed from power amplifier 6A2A3A6 move the test probe to TP1 on summing card 6A2A3A2.

r. Move the "- to +" potentiometer on the control panel to its extremes. A voltage swing from plus 5 volts to minus 5 volts should be noted. If the tolerance extremes are more than 0.25V, replace 6A2A2A11 CR5.

s. Move the test probe to power amplifier card 6A2A3A6 test point TP2. This is essentially the output of driver 6A2A3A5. With the "- to +" potentiometer manual adjusted to the extremes, a voltage of plus or minus 30 volts dc should be noted. It should also be noted that this voltage is inverted with respect to preamplifier 6A2A2A4 (180 degree inversion thru amplifier).

t. Install the fuses in power amplifier 6A2A3A6 and check the gain of the stage. The servo should now respond to commands.

u. Remove summing card 6A2A3A2 and adjust R3 (feedback setting) to read 2.2k ohms between pins 1 and 2.

v. Set R24 (gain) for a reading of 10k ohms between pins 1 and 2. The servo is now ready for test operation.

w. Remove cable W101A6-J1 and switch "Auto-Manual" switch to "AUTO".

NOTE

Cable must be removed to insure that the computer signals are not being superimposed upon the test signal.

x. By use of the test fixture (see figure 6-24) computer simulated signals may be injected into the monitoring points TP10 and TP11 on the control panel. It should now be possible to continuously rotate the servo under test. A voltage swing of ±5 volts dc should be noted at 6A2A3A2.

NOTE

The test fixture is connected across ±10-volt power supply and the probes are connected to the wipers of the 1k "ganged" potentiometer connected to the monitoring points for computer simulation.

y. Move the probe on the oscilloscope to 6A2A3A6 TP2 and check for a voltage swing of approximately ±30 volts.

z. The adjustment of the XI servo is now complete.

6-159. Sun Rotational Servo. Adjustment of the sun rotational servo is accomplished by the following:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Remove the three fuses from card A3A7 (power amplifier).

d. Install card 6A2A3A11 (summing card).

e. Install card 6A2A3A10 (preamplifier in automatic mode, no manual function).

f. Install card 6A2A3A12 (preamplifier in automatic mode, no manual function).

g. Install card 6A2A3A9 (buffer inverter in automatic mode, preamplifier in manual mode).

h. Install card 6A2A3A8 (driver in both modes).

i. Install card 6A2A3A7 (power amplifier in both modes).

j. Turn all switches to "ZERO TEST" on summing card 6A2A3A11.

k. Connect the ground of a millivac or VTVM (item 19, table 6-1) to signal ground (TP27 on the control panel) and use remaining probe to check any of the test points except 6A2A3A7 TP2.

l. Adjust each of the amplifiers to as near a zero reading as possible.

NOTE

> The drive amplifier will not approach zero. This is because the gain is not 1:1 as are all the other Donner stages and is more subject to noise. A reading of 25 mv is a satisfactory reading for this stage.

The 1:1 stages closely approach zero voltage when properly adjusted. The zeroing potentiometer is visible from the handle of each card. Adjust each potentiometer slowly and pause periodically to give the amplifier a chance to settle.

m. Turn the "auto-manual" switch on the control panel to the "MANUAL" position.

n. Connect the test probes of an oscilloscope (item 21, table 6-1) between TP27 (gnd.) and TP18 on the control panel.

o. When the "- to +" potentiometer on the control panel is turned from one extreme to the other a voltage swing of approximately plus 8.0 volts to minus 8.0 volts should be noted. Due to the trim resistors on the potentiometers which limits voltage, a full plus or minus 10 volts dc will not be realized.

p. Return the test switches on summing card 6A2A3A11 back to the "OPERATE" position.

q. With the fuses still removed from power amplifier 6A2A3A7 move the test probe to TP1 on the summing card.

r. Move the "- to +" potentiometer on the control panel to its extremes. A voltage swing from plus 5 volts to minus 5 volts should be noted. If the tolerance extremes are 0.25 volts or more, replace 6A2A3A11 CR5.

s. Move the test probe to power amplifier card 6A2A3A7 test point TP2. This is essentially the output of driver 6A2A3A8. With the "- to +" potentiometer manual adjusted to the extremes, a voltage of plus or minus 30 volts dc should be noted. It should also be noted that this voltage is inverted with respect to preamplifier 6A2A3A9 (180 degree inversion thru amplifier). Move the test probe to 6A2A3A7 TP1 and again rotate the potentiometer, a voltage swing of plus or minus 5 volts dc should be noted.

t. Install the fuses in power amplifier A3A7. The servo should now respond to commands.

u. Remove summing card 6A2A3A11 and adjust R3 (feedback setting) for 950 ohms between pins 1 and 2.

v. Set R24 (gain) for a reading of 1000 ohms between pins 1 and 2. The servo is now ready for test operation.

w. Remove cable W101A6-J1 and switch "auto-manual" switch to "AUTO".

NOTE

Cable must be removed to insure that the computer signals are not being superimposed upon the test signal.

x. By use of the test fixture (see figure 6-24) computer simulated signals may be injected into the monitoring points TP19 and TP20 on the control panel. It should now be possible to continuously rotate the servo under test. A voltage swing of plus or minus 5 volts dc should be noted at 6A2A3A11 TP2.

NOTE

The test fixture is connected across the plus or minus 10-volt power supply and the probes are connected to the wipers of the 1k "ganged" potentiometers connected to the monitoring points for computer simulation.

y. Move the probe on the oscilloscope to 6A2A3A7 TP2 and check for a voltage swing of approximately plus or minus 30 volts.

z. The adjustment of the sun rotational servo is now complete.

6-160. Sun Peripheral Servo. Adjustment of the sun peripheral servo is accomplished as follows.

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Install card 6A2A4A1 (preamplifier).

d. Install card 6A2A4A3 (driver).

e. Install card 6A2A4A4 (power amplifier).

f. Do not install card 6A2A4A2 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 0.350 ohms between pins 1 and 2, and R24 to a value of 700 ohms (summing card).

h. Remove the fuses from power amplifier 6A2A4A4 and install summing card 6A2A4A2 in its designated position.

i. Turn the sun periphery auto/man switch on the control panel to the "MAN." position and connect the oscilloscope (item 21, table 6-1) probes between TP27 (gnd.) and TP21.

j. Rotate the minus 55 degree, plus 55 degree potentiometer to both extremes and note a voltage swing of plus or minus 8.0 volts dc on the oscilloscope. Due to the trim resistors in series with this potentiometer a full plus or minus 10 volts dc will not be realized.

k. Turn switches S1 and S2 on summing card 6A2A4A2 to the "upward" or "ZERO TEST" position. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card 6A2A4A2. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier 6A2A4A1.

l. Move the VTVM test lead to TP2 on power amplifier 6A2A4A4 and adjust the trimpot for minimum voltage output. Due to the gain of this amplifier it is subject to more noise. A null reading in the vicinity of 25 mv is acceptable.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A4A2 to the "down" or "OPERATE" position and move the oscilloscope probes to TP1 on the summing card.

n. Rotate the minus 55 degree, plus 55 degree control panel potentiometer to the extremes. A plus of minus 5.0 volt dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Move the auto/man switch on the control panel to the "AUTO" position.

s. Remove cable 6J1W101 interface cable. Control panel point TP21 now ceases to be a monitoring point for the computer and instead becomes a signal injection point for testing the servo in the "AUTO" mode.

t. Insert only one leg of the test fixture into TP22 on the control panel. The servo should now respond to a rotation of the test fixture potentiometer in the same manner as with the manual potentiometer, thereby establishing the dynamic status of the system.

6-161. Alpha Servo. Adjustment of the Alpha servo is accomplished as follows:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Install card 6A2A4A8 (preamplifier).

d. Install card 6A2A4A6 (driver).

e. Install card 6A2A4A5 (power amplifier).

f. Do not install card 6A2A4A7 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 300 ohms between pins 1 and 2, and R24 to a value of 750 ohms (summing card).

h. Remove the fuses from power amplifier 6A2A4A5 and install summing card 6A2A4A7 in its designated position.

i. Turn the Alpha auto/man switch on the control panel to the "MAN." position and connect the oscilloscope (item 21, table 6-1) probes between TP27 (gnd.) and TP23.

j. Rotate the plus and minus six degree potentiometer to both extremes and note a voltage swing of plus or minus 8.0 volts dc on the oscilloscope. Due to the trim resistors in series with this potentiometer a full plus or minus 10 volts dc will not be realized.

k. Turn switches S1 and S2 on summing card 6A2A4A7 to the "upward" or "ZERO TEST" position. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card 6A2A4A7. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier 6A2A4A8.

l. Move the VTVM test lead to TP2 on power amplifier 6A2A4A5 and adjust the trimpot for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise and a null reading in the vicinity of 25 mv is acceptable.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A4A7 to the "down" or "OPERATE" position and move the oscilloscope probes to TP1 on the summing card.

n. Rotate the plus and minus six degree control panel potentiometer to the extremes. A plus or minus 5.0 volt dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Move the auto/man switch on the control panel to the "AUTO" position.

s. Remove cable 6J1W101 interface cable. Control panel test point TP23 now ceases to be a monitoring point for the computer and instead becomes a signal injection point for testing the servo in the "auto" mode.

t. Insert only one leg of the test fixture into TP24 on the control panel. The servo should now respond to a rotation of the test fixture potentiometer in the same manner as with the manual potentiometer, thereby establishing the dynamic status of the system.

6-162. Beta Servo. Adjustment of the Beta servo is accomplished as follows:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Install card 6A2A4A9 (preamplifier).

d. Install card 6A2A4A11 (driver).

e. Install card 6A2A4A12 (power amplifier).

f. Do not install card 6A2A4A10 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 250 ohms between pins 1 and 2, and R24 to a value of 800 ohms.

h. Remove the fuses from power amplifier 6A2A4A12 and install summing card 6A2A4A10 in its designated position.

i. Turn the Beta auto/man switch on the control panel to the "MAN." position and connect the oscilloscope (item 21, table 6-1) probes between TP27 (gnd.) and TP25.

j. Rotate the plus or minus six degree potentiometer to both extremes and note a voltage swing of plus or minus 5.0 volts dc on the oscilloscope.

Due to the trim resistors in series with this potentiometer a full plus or minus 10 volts dc will not be realized.

k. Turn switches S1 and S2 on summing card 6A2A4A10 to the "upward" or "ZERO TEST" position. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card A4A10. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier 6A2A4A9.

l. Move the VTVM test lead to TP2 on power amplifier 6A2A4A12 and adjust the trimpost on A4A11 for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise and a null reading in the vicinity of 25 mv is acceptable.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A4A10 to the "down" or "OPERATE" position and move the oscilloscope probes to TP1 on the summing card.

n. Rotate the plus or minus six degree control panel potentiometer to the extremes. A plus or minus 5.0 volt dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Move the auto/man switch on the control panel to the "AUTO" position.

s. Remove cable 6J1W101 interface cable. Control panel point TP25 now ceases to be a monitoring point for the computer and instead becomes a signal injection point for testing the servo in the "auto" mode.

t. Insert only one leg of the test fixture into TP26 on the control panel. The servo should now respond to a rotation of the test fixture potentiometer in the same manner as with the manual potentiometer, thereby establishing the dynamic status of the system.

6-163. Camera Focus Servo. Adjustment of the camera focus servo is accomplished as follows:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Install card 6A2A5A1 (preamplifier).

d. Install card 6A2A5A3 (driver).

e. Install card 6A2A5A4 (power amplifier).

f. Do not install card 6A2A5A2 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 325 ohms between pins 1 and 2, and R24 to a value of 825 ohms (summing card).

h. Remove the fuses from the power amplifier 6A2A5A4 and install the summing card 6A2A5A2 in its designated position.

i. Turn the lens focus auto/man switch on the control panel to the "MAN." position and connect the oscilloscope (item 21, table 6-1) probes between TP27 (gnd.) and TP5.

j. Rotate the 5', 150' potentiometer to both extremes and note a voltage swing of plus or minus 5.0 volts dc on the oscilloscope. Due to the trim resistors in series with this potentiometer a full plus or minus 10 volts dc will not be realized.

k. Turn switches S1 and S2 on summing card 6A2A5A2 to the "upward" or "ZERO TEST" position. With a millivac or equivalent VTVM (item 19, table 6-1) check the voltage at TP1 of summing card 6A2A5A2. Adjust this voltage to as near zero as possible by means of the trimpot on the preamplifier (6A2A5A1).

l. Move the VTVM test lead to TP2 on power amplifier 6A2A5A4 and adjust the trimpot for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise and a null reading in the vicinity of 25 mv is acceptable.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card A5A2 to the "down" or "OPERATE" position and move the oscilloscope probes to TP1 on the summing card.

n. Rotate the 5', 150' control panel potentiometer to the extremes. A plus or minus 5.0 volts dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Move the auto/man switch on the control panel to the "AUTO" position.

s. Remove cable 6J1W101 interface cable. Control panel point TP5 now ceases to be a monitoring point for the computer and instead becomes a signal injection point for testing the servo in the "auto" mode.

t. Inset only one leg of the test fixture into TP6 on the control panel. The servo should now respond to a rotation of the test fixture potentiometer in the same manner as with the manual potentiometer, thereby establishing the dynamic status of the system.

6-164. Camera Carriage Servo. Adjustment of the camera carriage servo is accomplished as follows;

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Install card 6A2A5A8 (preamplifier).

d. Install card 6A2A5A6 (driver).

e. Install card 6A2A5A5 (power amplifier).

f. Do not install card 6A2A5A7 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 150 ohms between pins 1 and 2, and R24 to a value of 6k ohms (summing card).

h. Remove the fuses from power amplifier 6A2A5A5 and install summing card 6A2A5A7 in its designated position.

i. Turn the camera carriage auto/man switch on the control panel to the "MAN." position and connect the oscilloscope (item 21, table 6-1) probes between TP27 (gnd.) and TP7.

j. Rotate the 5', 150' potentiometer to both extremes and note a voltage swing of plus or minus 5.0 volts dc on the oscilloscope. Due to the trim resistors in series with this potentiometer a full plus or minus 10 volts dc will not be realized.

k. Turn switches S1 and S2 on summing card 6A2A5A7 to the "upward" or "ZERO TEST" position. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card 6A2A5A7. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier 6A2A5A8.

l. Move the VTVM test lead to TP2 on power amplifier 6A2A5A5 and adjust the trimpot for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise and a null reading in the vicinity of 25 mv is acceptable.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A5A7 to the "down" or "OPERATE" position and move the oscilloscope probes to TP1 on the summing card.

n. Rotate the 5', 150' control potentiometer to the extremes. A plus or minus 5.0 volts dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Move the auto/man switch on the control panel to the "AUTO" position.

s. Remove cable 6J1W101 interface cable. Control panel point TP7 now ceases to be a monitoring point for the computer and instead becomes a signal injection point for testing the servo in the "auto" mode.

t. Insert only one leg of the test fixture into TP8 on the control panel. The servo should now respond to a rotation of the test fixture potentiometer in the same manner as with the manual potentiometer, thereby establishing the dynamic status of the system.

6-165. CRT Translation Window NO. 2 Servo. Adjustment of the CRT translation window No. 2 servo is accomplished as follows:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101)

c. Install card 6A2A6A1 (preamplifier).

d. Install card 6A2A6A3 (driver).

e. Install card 6A2A6A4 (power preamplifier).

f. Do not install card 6A2A6A2 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 1900 ohms between pins 1 and 2, and R24 to a value of 1000 ohms.

h. Remove the fuses from power amplifier 6A2A6A4 and install summing card 6A2A6A2 in its designated position.

i. Turn the CRT translation window NO. 2 auto/man switch on the control panel to the "MAN." position and connect the oscilloscope (item 21, table 6-1) probes between TP27 (gnd.) and TP1.

j. Rotate the 5', 150' potentiometer to both extremes and note a voltage swing of plus or minus 8.0 volts dc on the oscilloscope. Due to the trim resistors in series with this potentiometer, a full plus or minus 10 volts dc will not be realized.

k. Turn switches S1 and S2 on summing card 6A2A6A2 to the "upward" or "ZERO TEST" position. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card 6A2A6A2. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier (6A2A6A1).

l. Move the VTVM test lead to TP2 on power amplifier 6A2A6A4 and adjust the trimpot for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise, and a null reading in the vicinity of 25 mv is acceptable.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A6A2 to the "down" or "OPERATE" position and move the oscilloscope probes to TP1 on the summing card.

n. Rotate the 5', 150' control panel potentiometer to the extremes. A plus or minus 5.0 volt dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manaul control.

r. Move the auto/man switch on the control panel to the "AUTO" position.

s. Remove cable 6J1W101 interface cable. Control panel point TP1 now ceases to be a monitoring point for the computer and instead becomes a signal injection point for testing the servo in the "auto" mode.

t. Insert only one leg of the test fixture into TP2 on the control panel. The servo should now respond to a rotation of the test fixture potentiometer in the same manner as with the manual potentiometer, thereby establishing the dynamic status of the system.

6-166. CRT Translation Window NO. 4 Servo. Adjustment of the CRT translation window No. 4 servo is accomplished as follows:

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J1W101).

c. Install card 6A2A6A8 (preamplifier).

d. Install card 6A2A6A6 (driver).

e. Install card 6A2A6A5 (power amplifier).

f. Do not install card 6A2A6A7 (summing amplifier).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 1900 ohms between pins 1 and 2, and R24 to a value of 100 ohms.

h. Remove the fuse from power amplifier 6A2A6A5, and install summing card 6A2A6A7 in its designated position.

i. Turn the CRT translation window NO. 4 auto/man switch on the control panel to the "MAN." position and connect the oscilloscope probes between TP27 (gnd.) and TP3.

j. Rotate the 5', 150' potentiometer to both extremes and note a voltage swing of plus or minus 8.0 volts dc on the oscilloscope. Due to the trim resistors in series with this potentiometer a full plus or minus 10 volts dc will not be realized.

k. Turn switches S1 and S2 on summing card 6A2A6A7 to the "upward" or "ZERO TEST" position. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card 6A2A6A7. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier 6A2A6A8.

l. Move the VTVM test lead to TP2 on power amplifier 6A2A6A5 and adjust the trimpot for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise and a null reading in the vicinity of 25 mv is acceptable.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A6A7 to the "down" or "OPERATE" position and move the oscilloscope probes to TP1 on the summing card.

n. Rotate the 5', 150' control panel potentiometer to the extremes. A plus or minus 5.0 volt dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Move the auto/man switch on the control panel to the "AUTO" position.

s. Remove cable 6J1W101 interface cable. Control panel point TP3 now ceases to be a monitoring point for the computer and instead becomes a signal injection point for testing the servo in the "auto" mode.

t. Insert only one leg of the test fixture into TP4 on the control panel. The servo should now respond to a rotation of the test fixture potentiometer in the same manner as with the manual potentiometer, thereby establishing the dynamic status of the system.

6-167. Raster Size Servo (Window No. 2). Adjustment of the raster size servo (window No. 2) is accomplished as follows:

NOTE

No TP has been established for monitoring either the manual control voltage or the computer input voltage, therefore, voltage must be measured on the back of control panel 7A2A2, potentiometer R5, wiper arm No. 2.

a. Check to be sure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J17W510).

c. Install card 6A2A5A9 (preamplifier).

d. Install card 6A2A5A11 (driver).

e. Install card 6A2A5A12 (power amplifier).

f. Do not install card 6A2A5A10 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 500 ohms between pins 1 and 2, R24 to a value of 15k ohms.

h. Remove the fuses from power amplifier 6A2A5A12, and install summing card 6A2A5A10 in its designated position.

i. Set all switches on the summing card to "ZERO TEST".

j. Switch the range control for window No. 2 on control panel 7A2A2 to "SELECT AREA".

k. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card 6A2A5A10. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier 6A2A5A9.

l. Move the VTVM test lead to TP2 on power amplifier 6A2A5A12 and adjust the trimpot on 6A2A5A11 for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise and as complete a null reading as the previous stage cannot be obtained.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A5A10 to the "down" or "OPERATE" position and move the oscilloscope (item 21, table 6-1) probes to TP1 on the summing card.

n. Rotate the range control on control panel 7A2A2 to the extremes. A plus or minus 5.0 volt dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Switch the auto/select area switch on control panel 7A2A2 to "AUTO".

s. Install cable 6J17W510 and monitor the computer functions at the output stage of the first amplifier stage 6A2A5A10 TP1 to test for automatic operation.

6-168. Raster Size Servo (Window No. 4). Adjustment of the raster size servo (window No. 4) is accomplished as follows:

NOTE

No TP has been established for monitoring either the manual control voltage or the computer input voltage, therefore, voltage must be measured on the back of control panel 7A2A2, potentiometer R6, wiper arm No. 2.

a. Check to insure that all pertinent cables and power sources are properly installed.

b. Remove the interface cable (6J17W510).

c. Install card 6A2A5A16 (preamplifier).

d. Install card 6A2A5A14 (driver).

e. Install card 6A2A5A13 (power amplifier).

f. Do not install card 6A2A5A15 (summing card).

g. With an ohmmeter (item 24, table 6-1) adjust R3 for a value of 500 ohms between pins 1 and 2, and R24 to a value of 15k ohms.

h. Remove the fuses from power amplifier 6A2A5A13, and install summing card 6A2A5A15 in its designated position.

i. Set all switches on the summing card to "ZERO SET".

j. Switch the range control for window No. 4 on control panel 7A2A2 to "SELECT AREA".

k. By use of a millivac or equivalent VTVM (item 19, table 6-1), check the voltage at TP1 of summing card 6A2A5A15. Adjust this voltage to as near zero as possible by means of the trimpot on preamplifier 6A2A5A16.

l. Move the VTVM test lead to TP2 on power amplifier 6A2A5A13 and adjust the trimpot on 6A2A5A14 for minimum voltage output. Due to the gain of this amplifier, it is subject to more noise and as complete a null reading as the previous stage cannot be obtained.

NOTE

Make adjustments in small increments and pause between each to allow the amplifier to settle.

m. Return the zero-test switches on summing card 6A2A5A15 to the "down" or "OPERATE" position and move the oscilloscope (item 21, table 6-1) probes to TP1 on the summing card.

n. Rotate the range control on control panel 7A2A2 to the extremes. A plus or minus 5.0 volt dc swing should be noted.

o. Move the oscilloscope probe to TP2 on the power amplifier and again rotate the manual potentiometer to the extremes. A voltage swing of plus or minus 30 volts dc should be noted.

p. Remove the power amplifier and install the fuses.

q. Reinstall the power amplifier and the servo should respond to manual control.

r. Switch the auto/select area switch on control panel 7A2A2 to "AUTO".

s. Install cable 6J17W510 and monitor the computer functions at the output stage of the first amplifier stage 6A2A5A16 TP1 to test for automatic operation.

6-169. Adjustment and realignment of the raster size servo system follow-up potentiometers must be accomplished wherever it is replaced. To obtain optimum performance, follow the procedures set forth below:

a. Set controls for manual operation.

b. Establish 0 voltage at pin 2 of the range control potentiometer.

c. Rotate the follow-up potentiometer until the servo dial indicates "zero". The servo will drive to this point.

d. Lock the potentiometer shell by tightening the two mounting screws.

6-170. POWER SUPPLIES. The voltage and current settings of the power supplies used in the servo systems are covered under the appropriate heading in Section I. The plus and minus 10-volt d-c supplies must be set accurately to 10 volts and measurement of these voltages must be made with an extremely accurate voltmeter or oscilloscope (item 19 and 21, table 6-1). Of the six voltages used, these are the most critical. If the 10-volt supplies are not balanced and exactly equal to 10 volts, the docking position (simulated 5-foot distance) of the camera carriage and vidicon tubes will not be exact.

SECTION VII

PERIODIC INSPECTION AND SERVICE

7-1. GENERAL.

7-2. Periodic inspection and service of the visual system equipment is kept to a minimum through the use of many maintenance free features incorporated in the various assemblies and subassemblies. In other cases, no inspection on a periodic basis is required, because of the conditioned room in which the equipment is housed. Items of equipment which do require cleaning, inspection, and/or lubrication on a periodic basis are included in this section in tabular form. Those items which cannot be pre-determined as to the time lapse between inspections are also included with the symptoms which dictate the need for service. Maintenance personnel should be thoroughly familiar with the nature of the equipment before attempting any cleaning or service.

7-3. TELESCOPE AND SEXTANT SYSTEM.

7-4. The telescope, sextant, and associated equipment require very little maintenance. Each of the three major assemblies are covered separately under the appropriate heading in this section. Many of the areas checked normally are covered during functional testing; therefore, they are not included as a separate inspection in this section.

7-5. TELESCOPE.

7-6. Periodic inspection of the telescope, insofar as can be equated with satisfactory performance, is adequately covered by the functional test procedures of Section II. These tests are performed prior to each 350-hour operating cycle, and therefore, will serve the purpose of periodic inspection.

CAUTION

> The telescope is a sealed instrument. Consequently, the removal of covers, panels, or assemblies (with the exception of the operational removal of the eyepiece) merely for the purpose of inspection will result in more harm than good. The telescope should never be opened, or assemblies removed, except for specific repair purposes.

Instructions for periodic inspection, if any, for the scene generating equipment (MEP, celestial sphere, and C/S illuminator and occulting assembly) are prescribed under separate headings in this section.

7-7. Visual inspection of the telescope exterior and the maintenance of cleanliness is a continuing operation. Cover panel fastener tightness and

the tightness of electrical connections on terminal boards 13TB2 and 13TB3, on the cover plate of the reticle occulting and lens assembly must be maintained. The accumulation of dust on any portion of the telescope exterior must be prevented. No specific periods for this type of inspection and service can be established and no lubrication is required for the C/M occulting assembly or the rotating reticle assembly.

7-8. PREVENTIVE MAINTENANCE. The sunshafting lamp, installed in the lens and mirror housing assembly as shown in figure 1-20 has a rated average life of 300 hours, based on continuous use. To prevent possible failure of the lamp during a simulated mission, replacement is recommended following two consecutive operating periods of 350 hours. The lampholder assembly is secured to the front of the lens and mirror housing assembly by four No. 6-32 screws.

CAUTION

> Seal the opening into the lens and mirror housing assembly with barrier material while the lampholder is out of the assembly.

7-9. SEXTANT.

7-10. The regular performance of the functional tests, prior to each 350-hour operating period, as prescribed in Section II, serves adequately as periodic inspection of the sextant, insofar as performance is concerned. Visual inspection of the sextant exterior and the prevention of dust accumulation is a continuing operation and must be rigidly enforced.

CAUTION

> The sextant is a sealed optical instrument. The removal of covers merely for the purpose of inspection is, because of the possibility of the entrance of dust or other contamination, more likely to result in malperformance than to serve any useful purpose. Therefore, the removal of covers must only occur when necessary for repair, replacement, or for the performance of preventive maintenance, as prescribed in this section.

7-11. REPLACEMENT OF LIGHT SOURCES. Replacement of the various lamps is required periodically. Each of the particular lamps is discussed in the following paragraphs.

NOTE

All lamps stocked at the using site must be aged for ten hours, according to Government Specification for MS lamps.

7-12. Landmark and Starfield Light Source Lamps. Both lamps installed in the combined landmark and starfield light source assembly must be replaced following each 350-hour operating period. Access to the landmark lamp is obtained by opening the hinged cover on the landmark side of the light source assembly. Because of structural interference, access to the starfield lamp must be gained by removal of the rectangular access plate (see figure 7-1) or the frame bottom cover panel under the combined light source assembly. Following removal of the access plate, the starfield lamp can be reached through a cut-out in the interior partition on the starfield side of the assembly.

NOTE

The above procedure for starfield lamp replacement is applicable only if the lamp fails during an operating period.

7-13. Navigational Star Light Source Lamp. The navigational star light source lamp must be replaced at approximately 100-hour intervals. The lamp is mounted in a lamp holder, installed on the starfield generator, and is readily accessible by removal of the sextant top cover. Replacement of the lamp must, obviously, be made between navigational sightings programmed for a simulated mission.

7-14. Sunshafting Lamp. Replace the sunshafting lamp following each 350-hour operating period. See figure 1-9 for illustrating the location of the lamp which is immediately forward of the landmark starfield combining beam-splitter. As stated for the navigational star light source lamp, access to the sunshafting lamp is obtained by removal of the sextant top cover.

7-15. Rotating Reticle Edge-Lighting Lamps. Replacement of the reticle lamps is a repair operation (refer to Section V). The lamps have a minimum life of 4000 hours as required per MS24367. The lamps must be replaced following ten 350-hour operating periods.

7-16. LUBRICATION. The operable assemblies in the sextant require very little lubrication, because of the light loads and slow operating speeds involved. The carousel rotation gear train runs in an oil bath; approximately 1/2 pint of Aircraft Instrument Oil, Military Specification MIL-L-6085 is sufficient to submerge the gears.

NOTE

The avoidance of over-lubrication is of prime inportance in the maintenance and servicing of the sextant. Excess lubricant must be removed immediately; and only lint-free material, such as lens tissue, must be carefully used to wipe off any excess oil. Particular care must be exercised to prevent lubricating oil getting on terminal boards or electrical connections.

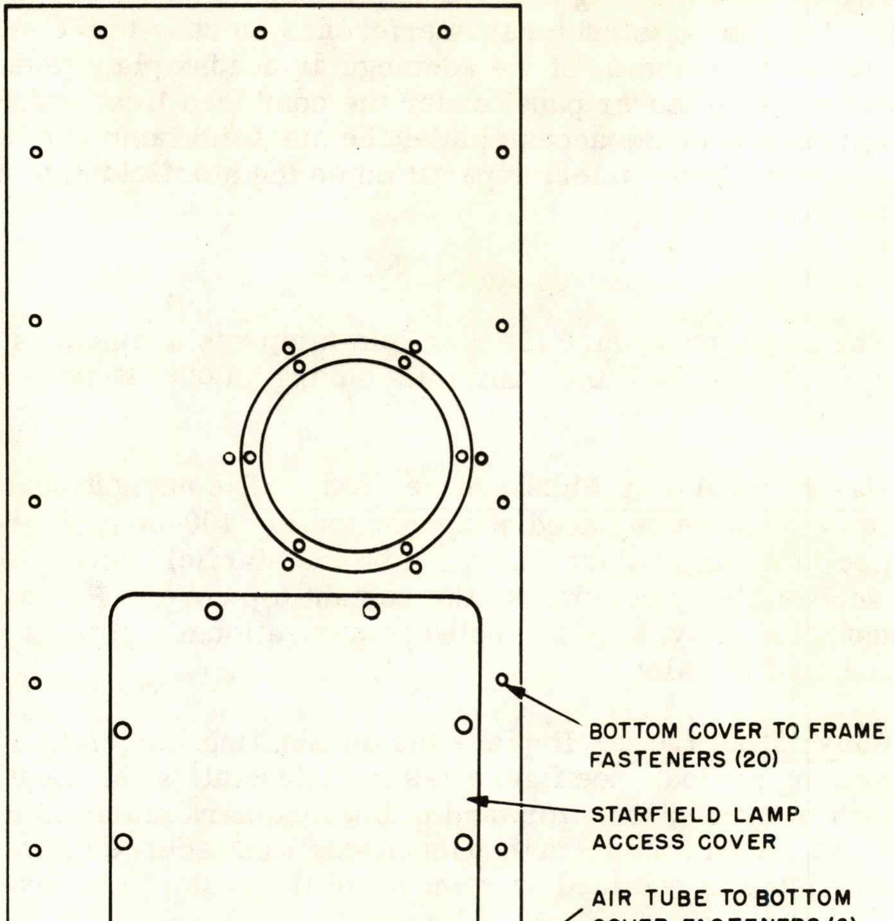


Figure 7-1. Frame Bottom Cover Panel, Below Combined Light Source

7-17. Lubrication Intervals and Application. A minute quantity of Aircraft Instrument Lubricating oil, Specification MIL-L-6085, is applied to the gearing, non-sealed rollers and bearings (slide gate and slide actuating mechanism), and the variable magnification lead screw at the completion of twenty 350-hour operating periods, or one year, whichever comes first. At the same time, the carousel gear box oil should be replaced with an equal quantity of the above specified oil. Access to the assemblies on the optical bed plate is obtained by removal of the sextant top cover and the left side sextant cover panel. Access to the carousel and slide actuator mechanism is by removal of the front, side, and rear cover panels.

NOTE

> In order to change the carousel gear box oil, the slide magazine must be removed to gain access to the gear box filler plug.

A recommended method of application of lubricant to the gearing and bearings is by means of a tooth-pick, or similar small wooden wand, dipped into the oil, and then lightly rubbed across the top surface of one of the gears in a train.

CAUTION

> To avoid possible damage to the gear teeth, do not use a metal applicator.

After the lubricant has been applied, operate the assembly through its entire range of movement, either manually or by test signals from the test resolvers in the electronics cabinet (unit 9).

7-18. Slide Magazine Slide-Holding Groove Lubrication. At the time of general lubricant application, as defined in paragraph 7-17, the slide-holding grooves on the undersurface of the slide magazine plate are cleaned and lubricated as follows:

CAUTION

> Prepare a clean compartment for storage of the landmark slides, prior to performing the following operations.

a. With the slide magazine removed from the carousel, (refer to paragraph 4-34) remove the individual slides from the magazine, and store them in the compartment previously prepared. Handle the slides by the metal frames - the glass surface must never be touched. Note the position of each slide in the magazine for reference at the time of replacement.

b. Clean the slide grooves and retaining springs thoroughly to remove loose or flaking old lubricant film. Use acetone to remove the old lubricant - dry the grooves and springs thoroughly before the next procedure.

c. Spray a light, even film of dry film lubricant, conforming to Specification MIL-L-23398, in the grooves. Use care in the spraying process to avoid uneven accumulations of the lubricant in the grooves.

d. When the lubricant is thoroughly dry, replace the landmark slides in the proper grooves, moving each slide back and forth several times to assure free movement.

e. Replace the magazine in the carousel at the appropriate time, depending on other procedures of the over-all lubrication operations.

7-19. COMBINED LIGHT SOURCE AIR INLET FILTER CLEANING. (See figure 7-1.) Each compartment of the combined light source is supplied with cooling air through a separate tube in which a 20-micron mesh, stainless steel filter is installed. Following each 350-hour operating period, the air filters must be cleaned. The air tubes are attached to the combined light source assembly bottom cover. Clean the filters as follows:

a. Manually hold the bottom cover (see figure 7-1) in place against the sextant support frame and remove the 20 screw fasteners.

b. Remove the cover from the frame, thus providing access to the outlet ends of the air tubes.

c. Use clean, dry, compressed air; and direct the air jet, approximately 30 psi maximum, through the tubes in the opposite direction from normal air flow until all dust has been blown out of the filters.

d. Replace the starfield light source lamp.

e. Replace the bottom cover under the light source assembly.

7-20. TELESCOPE/SEXTANT ELECTRONICS CABINET.

7-21. Due to the modular design of many of the assemblies contained in the electronics cabinet, only routine inspection and cleaning procedures are required between functional tests. Periodic inspections consist of visual checks which are made to aid in locating potential malfunctions, before they affect cabinet operation. Cleaning procedures consists of steps required to remove any dirt or other particles which accumulate in and around the various electronic assemblies.

7-22. VENTILATION DUCT. Prior to each function test performed on the cabinet, execute the following:

a. Check air filters for dust content and replace or clean, when necessary.

b. Check air inlet portion of duct for cleanliness.

c. Check that the flexible air ducts are secure and properly positioned.

7-23. CHASSIS. Prior to each functional test and after replacement of an assembly, check to ensure that all chassis are mechanically secure.

7-24. CABLE ASSEMBLIES AND CABINET WIRING. Prior to each functional test and after replacement of assemblies perform the following:

a. Check for accurate and secure connections.

b. Check for damage to mating surfaces (only during replacement of an assembly).

c. Check connectors and plugs for dirt and corrosion.

d. Check routing of wires and cabling through electrical conduits, making sure that strain is not applied.

e. Check insulation and plastic sleeving for cracks, signs of burning, and any other physical damage or visible deterioration.

7-25. POWER SUPPLIES. Prior to each operation of the visual system check meter and indicator readings.

7-26. OUT-THE-WINDOW DISPLAY EQUIPMENT

7-27. Maintenance and service of the out-the-window display equipment requires a knowledge of electronics, mechanics, and optics. In some cases, periodic maintenance procedures can be accomplished and are so indicated. In many cases, however, no specified time interval can be determined; as the nature of the equipment demands that service be accomplished only when the need arises.

7-28. CLEANING OF LENSES, MIRRORS, AND BEAMSPLITTERS. Cleaning of these optical units should only be accomplished when absoultely required and conducted in accordance with the given procedures.

7-29. Dust Removal. Use a General Electric portable vacuum cleaner, model MVL or equivalent, and a Black and Decker two-inch long-bristle dusting brush attachment, No. 6475 or equivalent, for cleaning dust from the optical components. Brush the dust lightly to loosen and remove with the vacuum cleaner.

7-30. Grease Removal. Use Acetone and a soft, lint-free cloth for grease removal. Moisten the cloth with acetone and wipe lightly in the local area of the grease spot.

CAUTION

Do not rub.

7-31. General Cleaning. Use distilled water or Windex (without ammonia D) and a diaper cloth. Spray the surface and wipe lightly with the diaper cloth. Remove any resulting lint with a camel-hair brush.

CAUTION

Do not use lens tissue for optical equipment cleaning as many varieties of lens tissue contain chemicals harmful to optical surface coatings.

7-32. CELESTIAL SPHERE. Cleaning of the celestial sphere should be accomplished in accordance with the following:

a. Using the celestial sphere manual controls in the associated cabinet, rotate the sphere slowly and remove any lint or dust that has accumulated on the surface and the reflecting balls with the vacuum cleaner.

b. If deposits remain, brush the black surface or the balls with a camel-hair brush and, if further cleaning is required, follow brushing with a gentle wiping of the black surface or the balls with a soft, lint-free cloth. If contamination of the surface of the celestial sphere still remains, despite the employment of the previous procedure, remove the deposit with masking tape.

7-33. OCCULTING ILLUMINATOR ASSEMBLY TAPE. Cleaning of the occultation assembly tapes should be accomplished in accordance with the following procedures:

a. With the visual system manual controls, wind and unwind the tape. Remove any accumulated deposits with the vacuum cleaner.

b. Simultaneously with step a, inspect the tape for any signs of wear which would hinder proper windup of the tape.

7-34. WINDOW DISPLAY PNEUMATIC TUBES. (See figures 1-33 and 1-36.) Since the volume of the manifold assembly is approximately 1% of the volume of an individual pneumatic tube, a pressure drop on the order of 1% occurs during the measurement of the pressure within an individual tube. For this reason, pressure readings should be conducted at intervals of once per week,

unless image impairment indicative of loss of pneumatic pressure is observed. Pressure readings and adjustments have, as their purpose, assurance of pressure within the prescribed limits and detection of pneumatic leaks in the system. Pressure measurement and adjustment should be conducted in accordance with the following procedure:

a. Ensure that the individual pneumatic tube valves are open.

b. Open normally closed valve 5.

c. Close all other valves.

d. Ensure that the gage reads "0". If gage does not read "0", bleed off air at valve nine until a "0" reading is obtained.

e. Open the valve labeled "8" and record pressure reading.

f. Close the valve labeled "8" and bleed off pressure from manifold assembly at valve 9.

g. Open valve 7 and record pressure reading. Subsequently close this valve and bleed off pressure from manifold assembly at valve 9.

h. Repeat the above procedure for valves 6 through 1 to obtain data indicating the pressure of each pneumatic tube.

i. If any tube yields a pressure well below the mean pneumatic pressure of all tubes, conduct leak detection procedures as specified in Section V.

7-35. MISSION EFFECTS PROJECTOR POWER SUPPLIES. Preventive maintenance of the MEP power supplies is required at 1000 hour intervals to ensure optimum performance and prolong equipment life. The following procedure is provided as an accepted sequence for use by maintenance personnel and should be followed for each individual power supply.

a. Position the REMOTE-OFF-MANUAL switch to "OFF".

b. Remove the main power fuses.

c. Pry the filter on the front panel from its receptacle.

d. Clean the filter screen with a general purpose detergent and blow dry with low pressure compressed air.

e. Remove the relay module and inspect the powerstat and brushes. Replace brushes as necessary.

f. Inspect the fan blade and motor. Clean any dust and grease from the components and check the tightness of the fan blade retaining screw.

g. Check cable connections and wiring for burning and fraying.

h. Replace the components and fuses. Check for proper operation.

7-36. RENDEZVOUS AND DOCKING EQUIPMENT.

7-37. The rendezvous and docking equipment, and associated equipment, requires very little maintenance. Cleaning and lubrication procedures for the optical system are presented in a tabular format. Units with shorter maintenance procedure requirements are presented in paragraph form.

7-38. CAMERA CARRIAGE.

7-39. Before installing the carriage, the gear rack must be thoroughly cleaned. Dirt or any similar obstruction will drastically affect the slow speed operation of the carriage. Cleaning should be done with a brush, followed by a visual inspection of the gear and trestle rail for foreign particles. Cleaning should be accomplished as often as needed.

7-40. WAVEFORM MONITOR.

7-41. Maintenance and service of the waveform monitor requires only that the instrument be calibrated every 500 hours of operation. For calibration and adjustment procedures, refer to Section VI.

7-42. RENDEZVOUS DISPLAY SYSTEM.

7-43. The optical equipment is, by nature, critically sensitive to its surroundings. It is imperative, therefore, that this equipment be kept clean and smooth running for optimum performance. Table 7-1 is designed to provide a systematic service schedule which will result in a short shut-down period and maintain maximum efficiency.

Table 7-1. Periodic Inspection and Service

Unit Name and Model Number	Daily Inspection	Weekly Inspection	Monthly Inspection	Semi Annual Inspection	Yearly Inspection	Servicing Material	Lubrication and MIL Spec. No.
1. R&D Trestle Assembly							
a. Rails	N/A	1. Clean and dry 2. Inspect for nicks	N/A	N/A	N/A	1. Kerosene (Federal Spec. No. W-K-211) 2. Diaper Cloths	N/A
b. Gear Track	N/A	1. Clean and dry 2. Inspect for broken or chipped teeth	N/A	N/A	N/A	1. Kerosene (Federal Spec. No. W-K-211) 2. Compressed Air	N/A
c. Front (Model) End Bearings	N/A	N/A	Lubricate lightly	N/A	1. Inspect all moving parts	N/A	Socony DTE light oil or pure mineral oil having a viscosity of SAE 10
					2. Replace all bearings		VV-D-611 or MIL-L-2105B
d. Model Angle Drive	N/A	N/A	1. Inspect top and bottom gears 2. Clean gears, if soiled, and lubricate lightly	N/A	N/A		Socony DTE light oil MIL-L-2105B
e. Slip Rings	N/A	N/A	1. Clean 2. Inspect for grooves or nicks 3. Inspect brushes for wear	N/A	N/A	1. Deoxidizer	N/A
f. Sun Track Chain	N/A	1. Clean (in horizontal position), and dry with compressed air 2. Lubricate lightly	N/A	N/A	N/A	1. Kerosene (Federal Spec. No. W-K-211	Mobil 3 in 1 oil VV-L-820B
g. Sun Carriage	N/A	N/A	1. Inspect carriage and track for proper clearance 2. Inspect microswitches for bent arm and operation	N/A	N/A	N/A	N/A

Table 7-1. Periodic Inspection and Service (Cont)

Unit Name and Model Number	Daily Inspection	Weekly Inspection	Monthly Inspection	Semi Annual Inspection	Yearly Inspection	Servicing Material	Lubrication and MIL Spec. No.
h. Sun Lamps	N/A	Check for brilliance	N/A	N/A	N/A	N/A	N/A
i. Servos	N/A	1. Check mechanical smoothness (operate by hand) 2. Inspect gears and clutches for wear and damage	N/A	N/A	N/A	N/A	N/A
2. Carriage							
a. Gear Blacklash	N/A	1. Check carriage and gear rack for minimum backlash	N/A	N/A	N/A	N/A	N/A
b. Swing Way	N/A	1. Lightly lubricate the swing way, swing cams, and swing mirror cams	N/A	N/A	N/A	N/A	Mobil 3 in 1 oil VV-L-820B
c. Lenses	N/A	1. Inspect camera and zoom lenses and mirror surfaces for dust, dirt, and contaminants 2. Clean lenses if necessary	N/A	N/A	N/A	1. Windex (without ammonia D) 2. Diaper Cloth 3. Camel Hair Brush	N/A
3. Model House							
a. Ventilators and Filters	N/A	1. Inspect ventilators and filters 2. Clean and lubricate if necessary	N/A	N/A	N/A	Detergent solution (stock No. 7300-297300, 1 ounce of solution per 1 gallon of water)	Filter fluid or equivalent
b. Cable Drive Servo	N/A	N/A	Check microswitch for bent arms and general operation	N/A	N/A	N/A	N/A
4. R&D Waveform Monitor			Calibrate (refer to Section VI)				